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DEVELOPING CHIEF ENGINEERS IN SWIFT'S CHICAGO PLANT

Going Through the "Mill" and the Plant in Which They are Trained

RECOMMENDATIONS FREQUENTLY AMOUNT to no more than the paper they are written on, and an engineer's ability, very often, can be judged best by bringing him in contact with numerous and varied problems, not only under average conditions but also those of rare occurrence and serious nature. In short, an engineer of ability must have gone "through the mill."

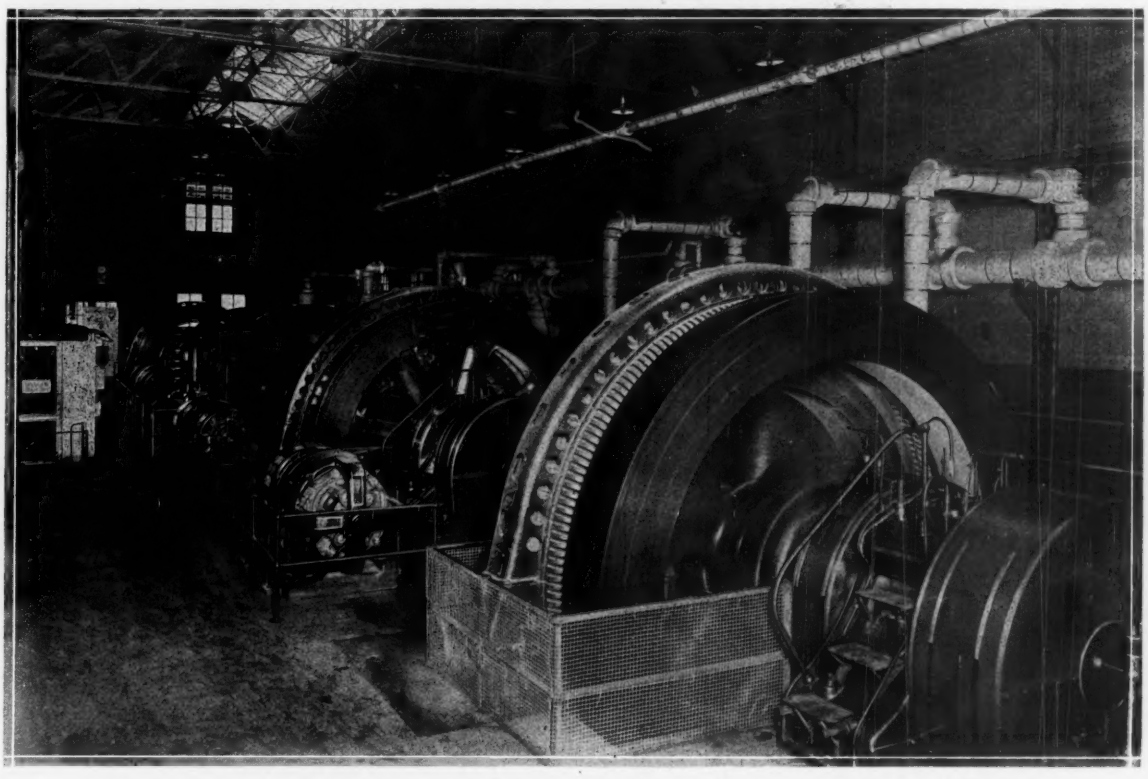


FIG. 1. THE GENERATOR ROOM, SHOWING EXCITER UNITS, GENERATING UNITS AND SWITCHBOARD

P. J. Slagle, chief engineer over all Swift Packing Co.'s power plants, has evolved a system of training men for the power plants under his supervision which thoroughly tests the ability of the engineers and affords him direct opportunity of determining the fitness of his men for outside stations not so directly under his observation. It is the policy of the company not to appoint a man as chief engineer of a branch plant until he has spent some time under Mr. Slagle's direct supervision in Chicago, in other words, until he has been "through the mill," as the engineers call the Chicago system of plants.

Nearly all up-to-date manufacturing concerns require a meeting of the heads of the various depart-

ments at least once a month; more often once every week. At Swift's main plant, the head engineers and foremen directly concerned are required to report in person to Mr. Slagle every day. He interviews them singly and if necessary calls in others, if some adjustment or discussion is required between several men.

Every morning between the hours of 7 to 9, the men "line up" on the day's work while some of them may be reporting to the chief. This "line up" consists of discussing the various improvements or alterations around the numerous Swift plants at the stock-yards, and brings the men in direct contact with one another so that the best means can be suggested for the most rapid and necessary repairs or alterations of the various plants and the men can "line up" on the required division of outside workmen such as machinists, ma-

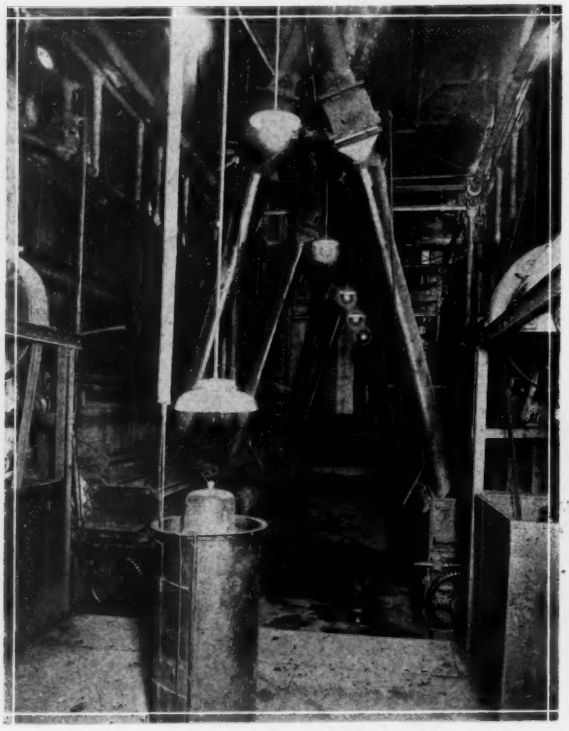


FIG. 2. IN THE BOILER ROOM, SMOKE RECORDER IN FOREGROUND

sons, boiler makers, steam fitters, electricians, plumbers or any other help not constantly employed in the power plant.

The most important event of the day for each engineer is the individual conference with Mr. Slagle himself, or, in his absence from the city, with the assistant in charge. This conference is required of the foremen whether they have much, little or even nothing to report. Everything is brought up, such as repairs of the past day, all contemplated changes for the present and any other matter even though it be of the least importance, barely worth mentioning. Operations, considered of everyday practice in ordinary plants, are brought up and if nothing else, then a good, friendly talk is given, impressing on the men the desirability of their daily presence even though no report can be made. The men are advised, criticised and praised as they deserve.

Every engineer in charge of a plant is required to supervise the repair and installation of any machinery or equipment connected with his plant. He must get his own gang of laborers and necessary skilled workmen, and see to it that the work is done. In sending out the work to the machine shop or other repair branch, he is expected to see that it is attended to and finished in time as required. No careless workmanship is permitted nor defective material allowed to enter into the repair or installation. All responsibility rests with the engineer in charge.

This training is to test his judgment and knowledge of good and bad work concerning those branches in which he is not expected to be proficient. His executive ability is brought out in the necessary handling of the men and the responsibility resting on him in keeping everything moving and in repair.

At the Chicago plant many problems present themselves that require more than average experience and intelligence, and information gained in conferences and discussions is not only absolutely reliable but is of such a nature that mere average practice and any amount of book-learning would avail but little. Engineers take their "finishing" course here, so that they are fully prepared, should occasion demand, to take charge of any of the Swift plants without there being cause to doubt their ability. It means more than mere personal satisfaction for a chief engineer of Mr. Slagle's ability and responsibility to be in touch and personally acquainted with the various head engineers of all the plants of the Swift Co.

Of course, assistants are required in this work. Trips are made to all plants and instructions and advice given similar to that in Chicago. Inspections are frequent and extravagances pointed out so that the outside engineers can receive the benefit of any worthwhile information in regard to economical operation and approximate costs of repairs or installations. All reports by the traveling assistants to their chief are such as would be expected of disinterested inspectors.

Monthly reports are required from all plants. These are compiled in sets in such a way that 2 plants of usual capacity, similar in labor or location problems, are compared with each other. In this manner friendly competition is aroused and repair statements become a source of knowledge to engineers unable to get a satisfactory estimate of their plants' operation. Comparisons are also drawn between the plants' operating costs at the present time with that of the year previous.

Machinery and instruments not available in outside plants can usually be found in Chicago and their operation thoroughly explained. Instruction is given in the determination of the method of approximate coal analysis and the calorific value of fuel. For testing purposes a Gebhardt steam flow meter is employed, each engineer being required to make tests of all power plant apparatus.

Plant System at Chicago

IN the manufacture of Swift's products, large amounts of the finished material are stored at the Union Stock Yards. It would not be good policy to have one storage place or packing plant, as too large a loss would be sustained in case of fire; so to avoid such a possibility 3 distinct units were formed, all interconnected with one 12-in. live steam and one 18-in. exhaust main, supplying the individual stations with steam and power in case of breakdown or fire, or should any one plant be overloaded, steam and power can be supplied to it from the remaining stations.

The 3 groups or stations are arranged in triangular position and consist of 17 boilers in one plant, 14 in a second and 8 in a third, besides being equipped with

refrigerating, pumping and power machinery. The 12-in. live steam pipe connecting the stations passes overhead in the yards and through the buildings with which it is connected. To prevent radiation and loss through condensation, it is covered with a 1¼-in. layer of 85 per cent magnesia with a course of well tarred paper on top; then comes a 1¼-in. layer of felt, also covered with a course of tar paper, and for the outside covering rubberoid roofing material is used, to prevent deterioration from moisture. It is claimed that in the cold winter weather, snow has been on the pipes for days at a time without melting. The 18-in. exhaust line passes over the tops of the buildings with outlets dropped for the numerous requirements. The pitch of the pipe lines is from one station to another with a large separator at the end to dispose of the moisture.

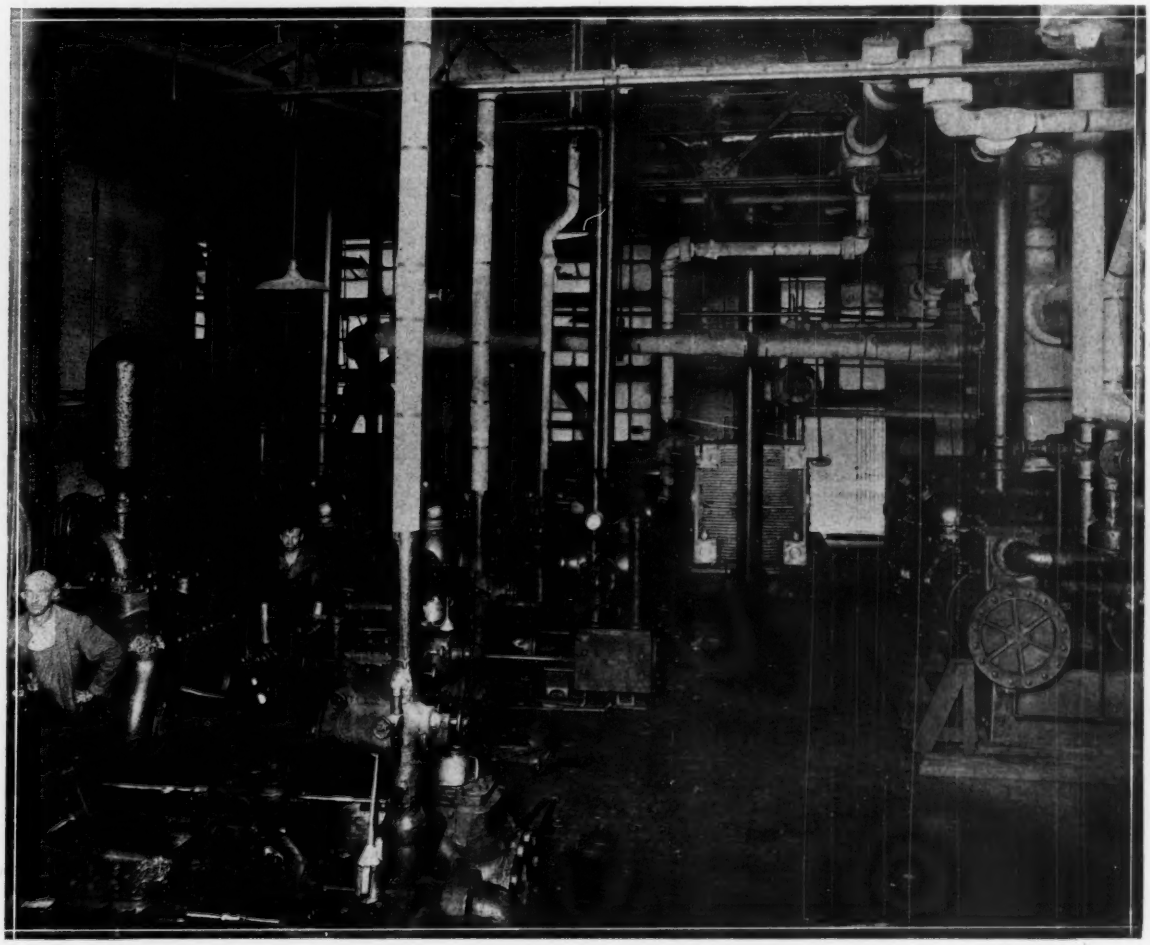


FIG. 3. FEED PUMPS AND PIPING ARRANGEMENT

West End Station

THE West End Station, as it is called, is the largest of the triple system, and was among the first stations in or about Chicago to generate 3-phase alternating current.

Steam supplied is generated by 16 Babcock & Wilcox, 400 hp., 36-in., double drum, water-tube boilers, carrying a working pressure of 160 lb., and containing 192 4-in. tubes, 18 ft. long, with a heating surface of 4000 sq. ft. Each boiler is equipped with an Illinois Stoker Co., chain grate stoker, having a surface area of 72 sq. ft., 2 4-in. Consolidated pop safety valves, a safety water column and a Babcock & Wilcox pressure gage. Two 2½-in. gate valves followed by asbestos packed plugs, supply the necessary blow-off. Between the gate valve and plug is connected a ½-in. drip pipe and globe valve. The gate valve is kept closed during the operation of the boiler but the drip valve is kept wide open, acting as telltale should the gate valve become leaky. Each boiler is equipped with 2 hand regulated dampers, one under the steam drum and the other at the usual connection between uptake and breeching. General Electric indicating steam flow meters are provided on each boiler. In the center of the boiler room, accessible to each fireman, is a recording smoke indicator.

The boilers are arranged in 2 rows of 8 each, with the fronts facing each other. Each set of 2 boilers has one common separating wall between them, but each battery is separated from the next by a 4-ft. alley. The boiler room has a transverse alley through the center which provides the necessary space for the installation or removal of any unit.

Overhead for each row of boilers is a brick and tile breeching connecting with the boiler uptake and conveying the smoke and gases to one common brick chimney, 16½ ft. in diameter by 167½ ft. high, at one end of the boiler room.

The stokers are operated by an overhead shaft, one for each row of boilers, chain driven by 7½-hp. Kriebel oscillating cylinder engines, with cross belt connection between the shafts for emergency should either engine break down or be under repair.

For the special high pressure required in the glycerine works of the plant, a 200-hp. Babcock and Wilcox boiler is used, operating at a working pressure of 185 lb. A special feed pump supplies the necessary water and a Locke governor regulates the pressure so that should it rise above the blowing off point, the steam will pass into the regular boiler header.

Coal and Ash Handling

COAL is supplied to the stokers from overhead bunkers. The coal storage capacity in the boiler room consists of 4 individual bins, each supplying 4 boilers, one battery in each row. Coal is brought to

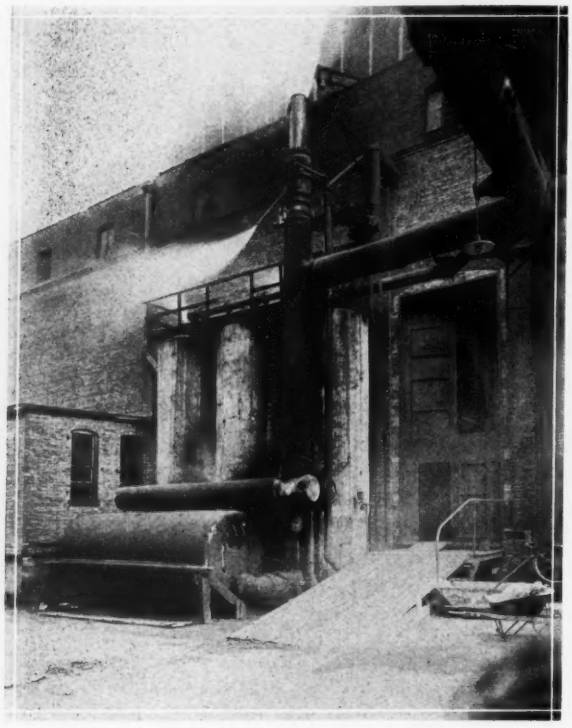


FIG. 4. HOME-MADE "PAVING BLOCK" FEED-WATER HEATER AND STORAGE

the plant in railroad cars which can be run into an alley separating engine and boiler rooms and there unloaded into 3 hoppers, one being provided with a coal crusher which can be used or not as desired. Underneath the hoppers a cross belt conveyor carries the coal to a main Link Belt Co. bucket conveyor which takes the coal up over the boilers where it is delivered as desired by an automatic dumper. The conveyor completes its circuit to the end of the bunkers, then back underneath them and down to the starting point.

Ashes drop into pits in the boiler room basement from which they can be raked into a separate ash conveyor which forms a loop by passing underneath the firing floor, up at one end, where the buckets are automatically dumped into a chute delivering them to railroad cars direct, then back over the coal bunkers and down at the other side, completing the circuit.

The driving power for the machinery consists in each case of induction motors, connected to the drive shaft by a friction clutch which permits the motor to come up to speed before assuming its load. A 20-hp. motor is used for the main coal elevator and conveyor, a 5-hp. for the short cross drive hopper conveyor, a 15-hp. for the ash handling arrangement, and a 15-hp. for the coal crusher.

Piping

IN many commercial enterprises the power plant becomes of secondary importance and often is not only cramped for room but also is given space which requires an unsatisfactory arrangement of engine and boiler rooms. In Swift's West End Plant the engine and boiler rooms are on an end-to-end arrangement with a 2-track railroad between them.

Each row of boilers has its own 16-in. overhead main passing to the engine room, all being connected together by 3 16-in. and 1 8-in. cross-headers and equipped with a gate valve between every 2 boilers. This arrangement forms a loop system not only providing against possible shut-down but also permitting tests of any particular unit or set of units. The branch pipes from boilers to the mains are provided with one wedge gate valve and one stop and check valve.

The feed-water piping likewise consists of mains cross connected at the center, one for each boiler row, provided with safety valves and pressure gages. These run along at the front and tops of the boilers and to facilitate the regulation of feed water supply to the boilers from them a double leg branch pipe, provided with a stop valve, is dropped to within easy reach of the fireman.

One 16-in. engine main runs lengthwise at one side of the engine room; another 12-in. main, leading from the opposite row of boilers, connects with the engine header near the middle, thereby forming a loop and providing for steam supply from the boilers in either of 2 ways.

The noncondensing group of engines exhausts into the 22-in. exhaust main which supplies the entire plant with steam at 5 lb. pressure and connects with the exhaust steam branches of the other stations.

Engine Room Equipment

STEAM power equipment is divided into condensing and noncondensing units, the condensing engines being equipped so that they can be run either as condensing units in summer when the exhaust steam requirements are small or as noncondensing in winter or during cold weather when more heat and steam are needed. All steam power units in the engine room have Filer & Stowell engines.

Comprising the main noncondensing units are 2 22 by 42-in., 120-r.p.m. cross-connected twin engines, direct connected to 3-phase, 60-cycle, 1850-amp., 250-volt Bullock Electric Mfg. Co. generators. In the condensing group are 3 cross compound, direct-connected units, one 13 by 28 by 42 in. driving a 694-amp., generator; another larger unit of 13 by 28 by 42 in., with a 1387-amp. generator, and the largest unit a 27 by 54 by 42-in. driving a 2775-amp. generator; all these generators are 250-volt, 60-cycle, 3-phase made by the General Electric Co.

Individual General Electric units provide direct current for the field coils of the generators; one consists of a 152-hp., 60-cycle, 220-volt, 525-amp. synchronous motor coupled to a 30-hp., 200-amp., 220-volt induction motor at one end and an 800-amp., 125-volt,

900-r.p.m. direct-current generator at the other. A second exciter consists of 2 267-amp., 150-volt, 900-r.p.m. direct-current generators coupled to each side of a 135-hp., 240-volt, 241-amp., 60-cycle synchronous motor. A 9½ by 15 by 6-in. compound marine engine, direct connected to a 150-volt, 334-amp., 400-r.p.m. direct-current generator makes a third exciter, while a fourth consists of 2 125-volt, 320-amp., 600-r.p.m., d.c. generators coupled to a 240-volt, 301-amp., 60-cycle synchronous motor.

The switchboard, 75 ft. long, is provided with Thomson polyphase wattmeters, ammeters and astatic voltmeters; with General Electric d.c. volt and ammeters and a.c. voltage regulators besides the necessary switches and rheostats.

To facilitate the erection or repair of machinery a 15-ton double hook, Whiting Foundry Co. hand-trolley crane is provided.

Pumping Machinery

SPACE for pumping and condensing machinery is provided for on one side of the main engine room. A 10 by 22 by 42-in. twin, tandem compound air compressor, driven by a 20 by 42 by 42-in. Ball cross-compound steam end, furnishes compressed air for blowing well water to a 1,000,000-gal. storage reservoir. Water for boiler feed is taken from Chicago city mains.

Condensation of exhaust steam from the condensing units occurs in a barometric condenser which is supplied with cold water from a cooling tower placed on top of the boiler house. Coupled to tower by one 10-in., 1800-r.p.m. American Well Works double suction centrifugal pump and 2 16 by 22 by 18-in. Fairbanks, Morse & Co. duplex compound plunger pumps, one being held in readiness for emergency or repair. A Deane 10 by 18 by 18-in. straight line pump is used to extract air from the condenser.

The boiler feed pumps are placed in the boiler room basement and consist of the following units: 2 Barr 18 by 10 by 12-in. and 2 Heisler 18 by 12 by 16-in. outside center packed plunger pumps.

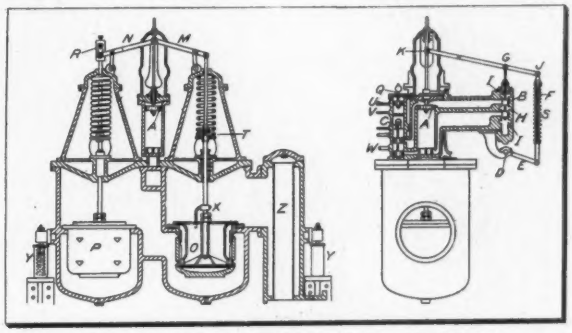
Feed water for boilers is heated in a special "home-made" heater consisting of 3 vertical tanks, interconnected at the top by a 4-in. water main and at the bottom to a 12-in. header which leads into a horizontal storage tank. A float valve in this tank is connected to a shutoff valve on the water line to maintain a constant level in the horizontal tank, and a surface blowoff set at the desired level is operated several times a day, removing scum and impurities from the water. Granite paving blocks in the vertical tanks present heating surface for the water and act as a storage for taking in and giving out heat. The main 18-in. exhaust line is connected to the vertical tanks and provided with a back pressure valve, while the boiler feed is taken direct from the horizontal storage tank, all tanks and pipes being thoroughly insulated to prevent radiation of heat.

STEAM TURBINE RELAY

By Thomas Sheehan

WHEN our 3000-kw. turbine was first started the oil relay, which operates the primary and secondary valves, gave some trouble. The primary valve O, would stick every once in a while, and kept getting worse. The valve and its cage was taken out and trued up in the lathe, about 0.004 in. was taken off the valve. It worked fine for about a month, and then got to sticking worse than before. The valve was taken out and 0.006 in. taken off. When assembled and the turbine brought up to speed, the valve spun around at high velocity, and made quite a racket. It was taken out again and a dog put on the valve stem, as shown at X, which was held in place by a set screw and a pin put through the set screw, also a bigger pin put in at T to prevent the valve stem from backing out of the crosshead, since then the valve has given no trouble.

The operation of the relay will be understood by referring to the accompanying illustration in which sections through the operating cylinder A and valve B are shown. Attached to the operating cylinder is a safety release valve C that is under the control of the speed-limit device. The governor operates the rock shaft D, and its motion is transmitted to the pilot valve B through the arm E, link F and floating lever G. According to whether the governor weights move in or out with increase or decrease in load, the pilot valve will either be raised or forced downward from its neutral position, admitting the oil (under pressure from chamber H) underneath or above the relay piston, as the case may be, at the same time opening the ports at the opposite end of the cylinder to exhaust through the passage I. The oil pressure chamber is located between the exhaust passages so that leakage escaping from the relay pistons is prevented.



CROSS-SECTION OF STEAM TURBINE OIL RELAY

A drain pipe is provided to entrap the small leakage past the relay-piston rod. As soon as the operating piston has traveled a short distance it returns the pilot valve to its closed position by means of the floating lever G, immediately restoring equilibrium, and thus holding the admission valve in a fixed position. The floating lever G first turns about the joint K as the position of the governor clutch which imparts the governor travel to the rock shaft D, changes, and then swings about J as the relay piston A begins to move. As soon as the governor gives the pilot valve B one direction of travel, the following motion of the operating piston will immediately reverse it, closing both ports and locking the valves in a fixed position until further movement of the piston takes place.

The motion of the relay piston A is transmitted to the primary valve O and the secondary valve P through the levers M and N. The arrangement of the 2 levers for the 2 valves will be found the same, with the exception that the secondary valve linkage is provided with an adjustable back-lash at R so that the time of opening of the secondary valve may be changed by the operator. Ordinarily, this valve is regulated to open at the moment the primary valve O has reached its maximum port opening.

To overcome the friction of rest provision is made for the fixed oscillation of the plunger, which causes

a very slight up and down motion of the main operating piston, and the main poppet valve. This, however, is not sufficient to cause any observable fluctuation in the flow of steam to the turbine. The advantage of this method is that the governor becomes more sensitive and the least move of the governor produces its consequent change of steam distribution. The oil relay apparatus will use more oil than the steam relay system, but this oil is afterward used in the bearings. The oil required for this apparatus involves nothing additional in the turbine system beyond the oil relay mechanism.

The same pump is used pumping the oil at a somewhat greater pressure, and delivering a constant supply to the relay system. A spring loaded by-pass valve is provided in the pipe line so that the oil in excess of that required by the relay escapes through the valve. The surplus oil together with the exhaust from the relay is led to a cooler and thence to the bearings, whence it is again returned to the reservoir and back to the pump.

The poppet valve possesses some novel features. The valve is essentially a combination of a poppet and piston valve, the poppet valve feature being in effect only when the valve is closed or nearly so. When the valve is partly closed. The opening past the valve seats is at all times very much greater than the passage through the ports. Hence wire drawing of the steam will take place at the latter point where it can do no harm. The valve ports are all of a peculiar form, so as to admit constant increments of steam for constant increments of valve lift.

In addition to the automatic throttle, an auxiliary safety steam valve Q is provided, receiving live steam at U. With leakage of steam past the piston it is held in a raised position due to unbalanced pressure. When the automatic trip operates, the steam from underneath this piston is exhausted through the outlet V. Through external linkage an oil valve W is then operated which relieves the pressure above the relay piston and admits the pressure beneath, correspondingly forcing it to the top of the cylinder, thereby closing the valve. In order to relieve the turbine casing of any strains due to the operation of the oil relay system, the steam chest is mounted on the bed plate and supported by heavy coil springs, as shown at Y and Y.

Steam is supplied to the valves through the strainer Z and the secondary receives its supply through the primary valve. The governor link F is provided with a compression spring S. On shutting down the machine, relieving the oil pressure, the effort of the governor weights to come together would tend to raise the primary valve. This would put a serious strain on the governor linkage, but the interposition of a comparatively light spring S in the linkage absorbs the governor travel without imposing any undue strain on the regulating mechanism.

Should the oil supply to the relay fail, the main spring would bring the valves to their seats, raising the relay piston to the highest position. The governor would then have a tendency to open the valves through the lever G. But as the spring S is unable to operate against the more powerful main-valve springs, it collapses and prevents the lifting of the main valve by the governor.

HEATING AND VENTILATING LARGE BUILDINGS

Forced Hot-Water Circulation

By Charles L. Hubbard

THE extent to which hot-water heating under forced circulation is used in connection with power plants makes it desirable for the engineer to be familiar with the equipment employed in systems of this kind. This method of heating is adapted to practically the same conditions as low-pressure steam and vacuum heating.

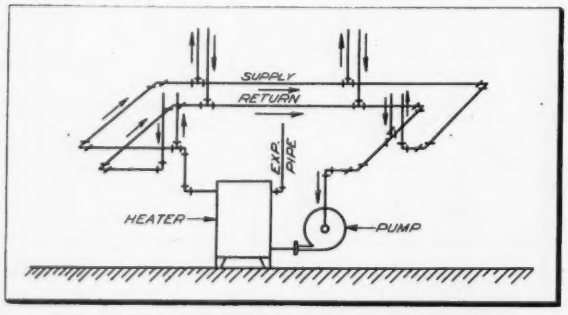


FIG. 1. THE 2-PIPE FORCED HOT-WATER SYSTEM

Water for circulation through the radiators is heated in specially designed heaters similar to those used for feed water, and both live and exhaust steam are employed for this purpose. The principal advantage of hot-water over low-pressure steam, with gravity return of the condensation to the receiver, is the ease with which the temperature of the building may be regulated by varying the temperature of the water or the rate of circulation. When compared with vacuum heating, it avoids the use of automatic return valves, which of course require more or less care to keep them in proper condition.

When the piping is properly laid out the system may be made practically self-venting, so that air

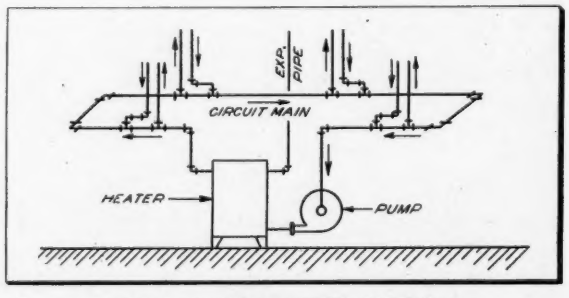


FIG. 2. CIRCUIT SYSTEM OF PIPING

valves may be done away with entirely, although some of the systems in common use require a pet cock upon each radiator for occasional use.

The essential parts of a system of this kind are a heater for warming the water to the required temperature, a pump for forcing it through the mains, and a system of piping for carrying it to the radiators and for bringing the cool return water back to the heater.

Apparatus Employed

IN systems of this kind it is customary to employ a closed feed-water heater with the connections reversed from the ordinary; that is, with the steam on the inside of the tubes and the water on the outside. Any good form of heater may be used for this purpose by providing it with connections of proper size.

In the ordinary form of feed-water heater the water flows through the tubes; and the connections are therefore small, making it necessary to substitute special nozzles of large size when used in the manner here described.

Water from the pump is made to enter the bottom nozzle and leave from the upper one, as with this arrangement the natural rising of the water due to its increased temperature tends to assist slightly in the circulation. Steam connection is made at the top and the condensation is trapped off at the bottom.

When both live and exhaust steam are used it is customary to employ separate heaters, trapping the oily drip from the exhaust to the sewer, and that from the live steam heater to the receiving tank. There is no reason, however, why the oil cannot be removed from the exhaust the same as in steam heating and the live and exhaust steam mixed in a single heater and the entire condensation be returned

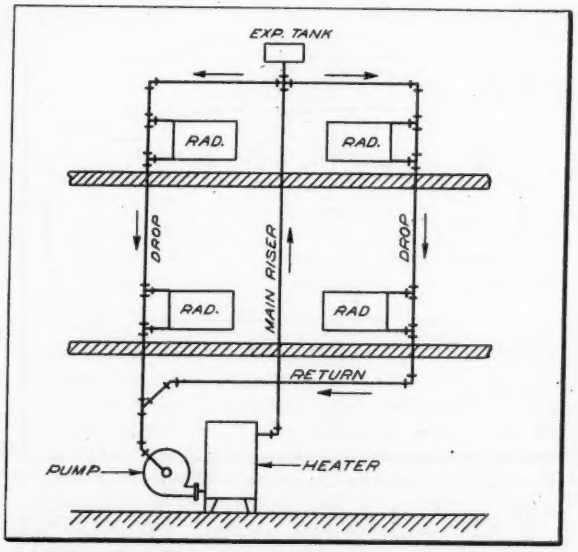


FIG. 3. OVER-HEAD SYSTEM OF DISTRIBUTION

to the receiving tank and thus saved. The required tube surface will depend upon the volume of water to be heated and the degrees rise, the temperature of the steam, and the average temperature of the water passing through the heater.

For ordinary conditions, with water entering the heater at 170 deg. and leaving it at 200 deg., we may count on the following efficiencies, in B.t.u. per square foot of tube surface per hour for different steam pressures:

TABLE I. EFFICIENCY OF HEATING SURFACE

Steam Pressure (gage)	Efficiency of Tube Surface
0 lb.	5,400 B.t.u.
10 lb.	11,000 B.t.u.
20 lb.	15,000 B.t.u.

Taking the average efficiencies of radiating surface of different kinds with the water at the temperatures stated above, we have the following ratios between radiating and tube surface for different steam pressures, as given in Table II:

TABLE II. RATIOS OF RADIATING TO TUBE SURFACES

Type of Radiating Surface	0 lb.	10 lb.	20 lb.
	Ratio between Radiating and Tube Surface		
Direct	30	60	80
Indirect	15	30	40
Fan Blast	5	10	14

As an illustration of the use of the table, suppose a building contains 6000 sq. ft. of direct radiation, 1500 of indirect, and 1000 of fan blast; how many square

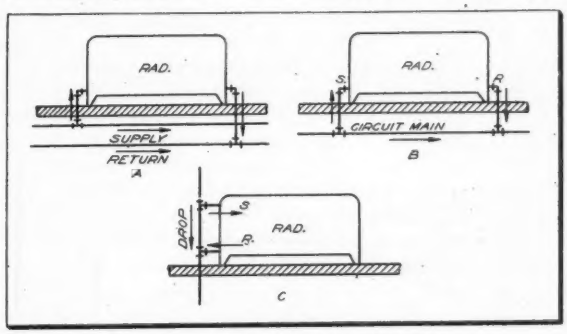


FIG. 4. RADIATOR CONNECTIONS

feet of tube surface should the heater contain, using steam at 0 gage, or atmospheric pressure? Making use of the table, we have:

$$6000 \div 30 = 200$$
$$1500 \div 15 = 100$$
$$1000 \div 5 = 200$$

Total, 500 sq. ft. of tube surface.

As the average commercial feed-water heater is rated in horsepower, on a basis of ⅓ of a sq. ft. of surface per horsepower, the capacity of the required heater in the preceding example will be $3 \times 500 = 1500$ hp.

Means for Circulating

CENTRIFUGAL pumps are particularly adapted to this class of work on account of their simplicity. They have no valves, produce a continuous flow of water, and for the low heads against which they operate have a fair efficiency.

They are commonly driven either by a direct-connected steam engine, or electric motor, although the steam turbine is well adapted to this purpose and is coming into quite general use.

TABLE III. LOW-SPEED CENTRIFUGAL PUMP CAPACITIES

Gallons per min.	Size of Discharge inches	Diam. of Impeller inches	Feet Head, and Revolutions per minute			
			16	20	30	40
100	2	18	460	510	620	710
240	3	22	380	420	510	580
430	4	26	310	340	410	460
730	5	29	280	290	350	400
1000	6	32	240	260	320	360
1400	7	34	220	250	300	340
1800	8	36	210	240	280	320

In the latter case the pump is designed for a moderate speed and a geared connection is used. Table III gives data for low-speed pumps, adapted to a direct-connected engine drive, while Table IV is for

pumps running at speeds corresponding more nearly to those used in moderate-speed electric motors.

TABLE IV. HIGH-SPEED CENTRIFUGAL PUMP CAPACITIES

Gallons per Minute	Size of Discharge, inches	Diam. of Impeller inches	Feet Head and Revolutions			
			12	20	30	40
100	2	8	930	1190	1430	1630
240	3	9	810	1020	1220	1400
430	4	10	690	870	1050	1190
730	5	11	610	760	910	1030
1000	6	12	570	710	840	960
1400	7	14	490	610	720	820
1800	8	16	420	520	630	710

The horsepower for driving the pump is computed by the equation:

$$\text{hp.} = \frac{H \times G \times 8.3}{33{,}000 \times E}, \text{ in which}$$

H = pressure head, in feet, pumped against.
G = gallons pumped per minute.
E = efficiency of pump, commonly taken as 0.5 in this class of work.

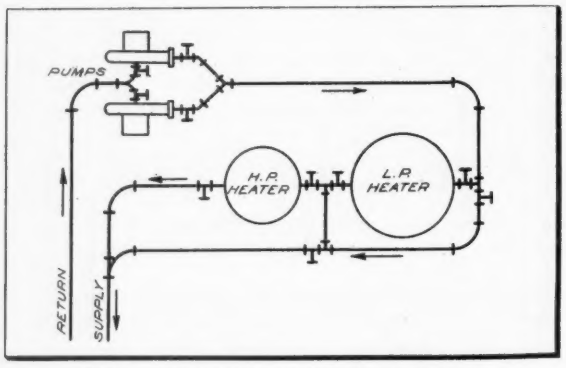


FIG. 5. CONNECTING HEATERS IN SERIES

In power plants having electric generators it is usually the most convenient to employ a motor drive, either direct-connected, or geared.

Two complete outfits of pump and motor or engine should be provided, because the operation of the entire heating plant is dependent upon this one piece of apparatus, and there should always be a relay for use in case of repairs.

While a pump of considerable power is commonly used in this class of work, there are cases where the horizontal mains are of comparatively short length and the pressure required for moving the water through them is small; under conditions of this kind a circulator may be used. This is very simple in construction, consisting of a propeller placed in a by-pass in the flow main and driven by a direct-connected motor. A special deflecting valve forms part of the apparatus, so that propeller may be cut in or out of the system as desired.

The volume of water to be circulated may be found by the formula:

$$G = \frac{R \times E}{500 \times T}, \text{ in which}$$

G = gallons per minute.
R = square feet of radiating surface to be supplied, including uncovered mains and risers.
E = 170 for direct surface, 340 for indirect, and 1000 for fan blast coils.
T = drop in temperature of water passing through system, commonly taken as 30 deg.

Piping Systems

THERE are 3 general systems of piping in use for connecting the heater and the risers. The 2-pipe system is shown in diagram in Fig. 1, where the path of the water is indicated by the arrows. The supply and return mains are carried parallel with each other, the former decreasing in size and the latter increasing as the risers are taken off.

As the difference in pressure between the supply and return mains is greater nearer the heater than at the end of the line, throttling valves must be provided in the risers for equalizing the flow through all parts of the system. These valves are also useful in cutting out a pair of risers should leaks occur in any of the radiators connecting with them. The circuit system of piping is shown in Fig. 2.

In this case a single main of uniform size is carried entirely around the building, extending from the pump discharge back to the suction inlet. The supply risers are taken from the top of the main and the corresponding returns are connected into the side of the main a distance of 6 or 8 ft. further along the line as indicated in the cut.

It is evident that the pressure in the main drops continuously from the pump discharge to the suction inlet, and it is this difference in pressure between the points of connection of the supply and return risers, aided by their difference in temperature, which causes a circulation of water through them.

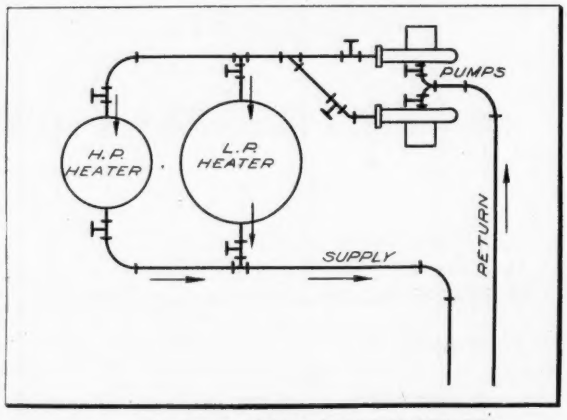


FIG. 6. PARALLEL ARRANGEMENT OF HEATERS

The over-head system of distribution, shown in Fig. 3, is especially adapted to office buildings, because only one riser or drop is required for each series of radiators, and also because no air valves are required upon the radiators with this arrangement.

The main riser is carried directly to the top of the building, where it branches and connects with the tops of the supply drops as shown. The return from the radiators in this case goes back into the same pipe and therefore cools the water to some extend in the radiators on the lower floors. This may be overcome by increasing the sizes of the radiators slightly on each floor downward. For example, if we figure on a drop in temperature of 30 deg. in the water between the supply and return, and an initial temperature of 200 deg., the water supplied the radiators on the first floor will be at a temperature of $200 - 30 = 70$ deg. and the relative efficiencies of 1 sq. ft. of radiation on the top and lower floors will be $\frac{200 - 70}{170 - 70} = \frac{130}{100}$ or 1.3.

That is, if the radiator sizes on the top floor are computed by the usual methods for a given temperature of water, then radiator sizes computed on the same basis for the first floor must be multiplied by 1.3 to offset the effect of the constantly cooling water as it passes downward. For example, suppose the rooms forming a tier in a 10-story building are uniform for the full height, and that 100 sq. ft. of radiation is required in each, if supplied with water at the same initial temperature. In this case, assuming the above conditions, the first floor radiator must contain $100 \times 1.3 = 130$ sq. ft., or the radiators must be increased 3 sq. ft. on each succeeding floor downward.

Methods of making the radiator connections are shown in diagram in Fig. 4. Fig. A and B are for the 2-pipe and circuit systems, shown in Figs. 1 and 2 respectively. These radiators require air valves, as all connections are at the bottom, and the tops of the sections form a trap for the collection of air.

The expansion pipe in these 2 systems is usually carried up from the heater to the tank independently of any other piping, as indicated in Figs. 1 and 2. The connection shown in Fig. 4C is for the down-feed system, Fig. 3, and requires no air valve, as all air in the system will find its way upward to the expansion tank through the expansion pipe taken off from the top of the main riser.

The sizes of the supply and return risers for the circuit system may be made the same as for gravity circulation, and those for the 2-pipe and down-feed systems, one size smaller. Under ordinary conditions about 1.2 gal. of water per minute should pass through the main for each 100 sq. ft. of direct radiation to be supplied.

Table V. gives the capacities of pipes of different sizes for the velocities of flow commonly employed. These vary under ordinary conditions from 300 to 600 ft. per minute according to the size of the main.

TABLE V. CAPACITY OF PIPES

Size of Main. Inches	Capacity, Gal. Per Min.
3	100
4	250
5	400
6	700
7	1000
8	1500

Two general methods of making the pump and heater connections are shown in Figs. 5 and 6. In the first of these the live and exhaust steam heaters are placed in series, which is the method employed in the Evans-Almiral system.

In the second case the heaters are placed in parallel and the flow of water proportioned between the two by throttling the valves in the connections.

The pumps are so arranged that either may be used and the heaters are made entirely independent by means of valved by-pass connections.

RELIEVING AN OVERLOADED ENGINE

Strengthening the Frame; Adjusting the Governor

BY RECEIVER

LOCATED in the glazing mill of a large paper mill in this city is a 20 by 42-in. Green engine, which is one of the older machines built from the patterns of the improved engine of this build.

As several large calendar machines are driven from this engine, and as the several rolls are screwed down with several tons pressure, it is evident that considerable power is required to drive the machines. These calendars are driven by clutches which are thrown into and out of gear with a shaft that receives power from a pulley on the jackshaft. As these machines are often suddenly stopped and started and frequently more than one machine at a time, the engine is practically on street railway or rolling mill work.

As usual with successful concerns, one addition after another was placed on the engine until its economical load was far exceeded and the regulation unstable. This plant is in charge of an engineer, who, while young in years, is old in experience, and one of the brightest men in the business. This engineer advised the owners to replace this engine with one of suitable proportions to carry satisfactorily the load. The owners think that the engine should be run as long as possible after the engineer made the improvements described here, although it involved a considerable expenditure and the prospects of selling the engine at a satisfactory figure are small.

As stated, the engine originally ran at 85 r.p.m. The speed was increased to 100 r.p.m. and a large pulley put on the jackshaft. After this change it was found from the indicator cards that the steam pressure could not be maintained as good practice calls for. Therefore a steam reservoir, 36 in. in diameter and 6 ft. long, was connected into the steam pipe near the engine, which overcame this.

As originally built, this size engine did not have a pedestal under the outer end of the guides. The engineer took the necessary dimensions and made a suitable support, which materially strengthened the frame at the point indicated, Fig. 1. The joint uniting the cylinder and the girder frame showed signs of distress, so additional bolt holes were drilled in the cylinder and frame flanges and larger bolts used.

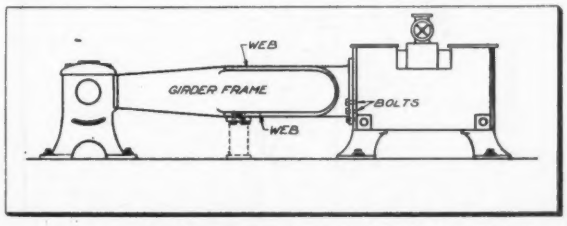


FIG. 1. STRENGTHENING FRAME OF GREEN ENGINE

As the usual safety pin in the Corliss engine is not used on this engine, its place is taken by a slotted collar, on which the governor rests when starting, and the collar is turned into such a position, on the governor spindle, that the slot comes in line with the crossbar, as seen in Fig. 2 at F. This allows the governor to drop sufficiently low so that the steam valves are not opened, as will be explained later.

After these changes had been made the engine was still laboring and the limit of steam pressure was carried; when a heavy load came on the governor

dropped to its lowest position and the engine stopped. If this slotted collar was blocked in the starting position, and the governor belt broke or anything occurred to stop the governor's revolving, the engine would run away, to say the least.

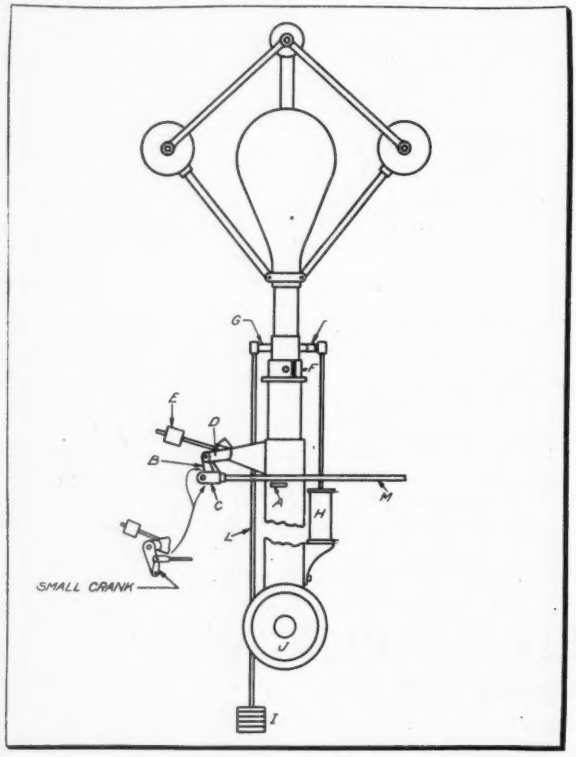


FIG. 2. GREEN GOVERNOR

To allow the collar to be blocked in the starting position and yet have the engine protected by an automatic stop, the engineer made and put on the device shown in Fig. 3. This consists of a lever of

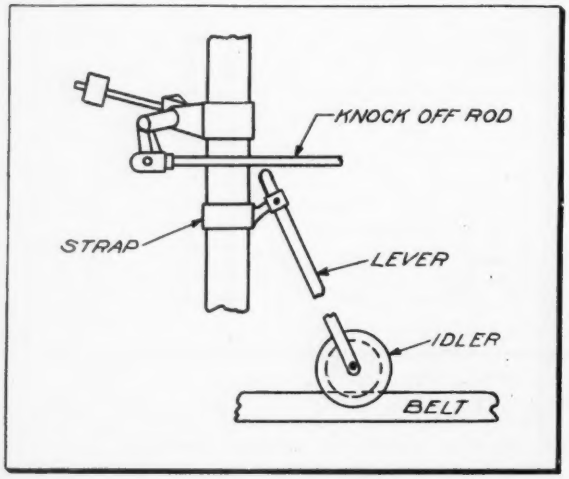


FIG. 3. ENGINE STOP DEVISED

suitable length journaled on a stud mounted on the governor column. The lower end of the lever supports an idler pulley, which rides on the governor belt. The safety stop of the engine originally consisted of a small crank mounted on the small rock shaft that moves the knockoff rod, and this crank normally is on its dead center. Mounted on the governor column is a small pin, A, Fig. 2. When the governor drops the knockoff rod strikes the pin which throws the small crank off its dead center, giving a larger motion or travel to the knockoff rod, which depresses the tappets to such an extent that they fail to engage the toes of the steam valves, thereby not opening them, which action would stop the engine.

As the lever is extended beyond its support, this end will rise when the governor belt breaks, allowing the force of gravity to cause the heavy end carrying

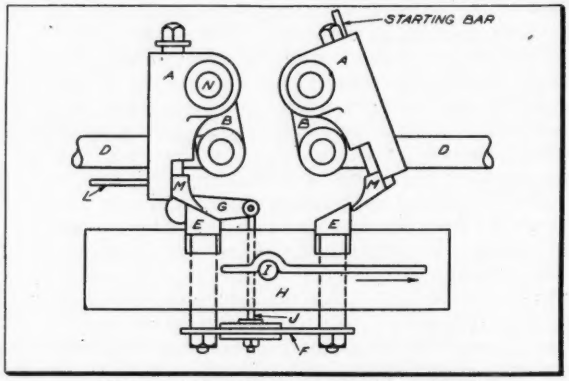


FIG. 4. VALVE GEAR OF GREEN ENGINE

the idler pulley to drop, coming into contact with the knockoff rod and acting the same as the small pin, A, Fig. 2, previously referred to. Thus the engine is protected by an efficient automatic stop, and the engine is allowed to take steam full stroke momentarily when necessary.

To relieve the engine of as much back pressure as possible, the exhaust pipe was replaced by 10-in. pipe where originally it had been 8 in., which was ample for the load the engine was designed to carry.

SUPPLEMENTING OF TECHNICAL EDUCATION by contact with actual engineering work, is most valuable. Every man who has been on the job will testify that the school training without a good deal of actual practice, to show just what the relation of the classroom work is to work in the actual engineering field, gives unbalanced training and impressions which have to be corrected. Most of the larger technical schools are now taking students on inspection trips to various industrial plants, with the view of giving the students an insight into actual operating conditions.

From the Ohio State University a party started on the 20th of April, spending a week in Gary, Ind., Chicago, Ill., and Milwaukee, Wis., going over and studying the principal manufacturing plants and central stations.

In order to give the maximum value to this trip, a bulletin was prepared, giving the itinerary and explaining the principal features of each plant to be visited, showing the important points, and also an instruction pamphlet explaining what should be investigated in each line of apparatus. Interleaf copies of the bulletin were furnished to the students, so that they could make notes in addition to those already given. By this means it is made certain that nothing of importance need escape the student if he is alert to make the most of his opportunity, and no time is wasted in hunting for the things that he ought to see. It is an excellent idea and one on which the authorities of the University are to be congratulated.

CREEP OF BELTS

By W. F. Schaphorst

By making a simple experimental apparatus, as shown in Fig. 1, consisting of 2 unequal weights, a belt, and a loose pulley, the rotation of which can be controlled by the experimenter, the laws of belt creep may be easily determined.

To make slip impossible, weights should be chosen that are nearly equal; 9 and 10 lb., as suggested in the diagram, will do very well, thus making a pulling force of (10 lb. — 9 lb.) 1 lb.

Make a mark A on the pulley and a coinciding mark B on the belt. Allow the pulling force to rotate the pulley toward the right, in which case the pulley serves as the driven pulley of a transmission system. After the weight D has moved a convenient distance, stop it slowly to avoid the slip that might be caused by inertia. Then, by reversing the pulley and making it act as a driver gradually pull the weights back to their initial positions.

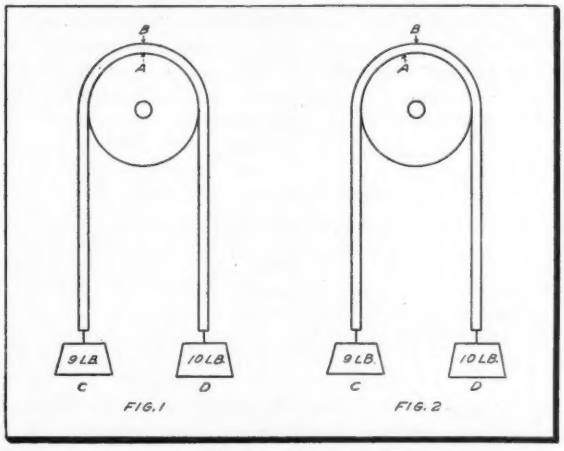


FIG. 1. FIRST POSITION OF BELT IN EXPERIMENT TO DETERMINE BELT CREEP
FIG. 2. CREEP OF BELT SHOWN BY EXPERIMENT

It will be found that A and B no longer coincide. Their relative positions will be about as shown in Fig. 2. Repeat experiment a second time as carefully as before and the gap between A and B will become double the initial distance. A third experiment will triple the distance, and so on. If equal weights are used there will be no pulling force and by rotating the pulley several times as before no gap will form between the points A and B.

The above clearly illustrates the phenomenon of belt creep. Each complete down and up motion of D represents a complete cycle of a belt transmitting power. All belts—leather, rubber, cotton and steel—are elastic to some extent and will therefore be stretched by weights C and D. The 9-lb. weight will obviously stretch the belt less than will the 10-lb. weight, hence one inch of belt moving onto the pulley as D descends is more than one inch in length when it leaves the pulley. The belt must creep slightly to compensate for this discrepancy. When the movement is reversed, as where a belt moves onto a driving pulley the action of the belt reverses and the stretched inch regains its original length of 1 in. Creep again occurs. In both cases the creep is toward the tightest side.

Where belts are continuous, as in all belt drives, the total creep may be easily computed as follows:

Let f_1 = tension in lb. per sq. in. on slack side;
f_2 = tension in lb. per sq. in. on tight side;
N_1 = r.p.m. of driving pulley;
N_2 = r.p.m. of driven pulley;
d_1 = diameter of driving pulley (including half the thickness of the belt on each side.)
d_2 = diameter of driven pulley (also including belt);
E = modulus of elasticity;
e_1 = elongation per inch due to f_1;
e_2 = elongation per inch due to f_2;
L = original length of belt unstretched.

From definitions in mechanics of materials

$$E = \frac{f_1}{e_1};\quad e_1 = \frac{f_1}{E}$$

also

$$E = \frac{f_2}{e_2};\quad e_2 = \frac{f_2}{E}$$

The entire length of the belt after being stretched by the unit stress f_1 will therefore be $L + \frac{f_1 L}{E}$. Similarly the entire length of the belt after being stretched by the unit stress f_2 will be $L + \frac{f_2 L}{E}$.

The length of belt received by the driving pulley determines the number of revolutions the driving pulley can make, whence,

$$N_1\, 3.1416\, d_1 = L + \frac{f_2 L}{E}$$

and for the same reason the length of belt received by the driven pulley determines the number of revolutions the driven pulley can make, or,

$$N_2\, 3.1416\, d_2 = L + \frac{f_1 L}{E}$$

Dividing the first equation by the second we get

$$\frac{N_1\, 3.1416\, d_1}{N_2\, 3.1416\, d_2} = \frac{L + \frac{f_2 L}{E}}{L + \frac{f_1 L}{E}}$$

Solving for N_2 we find

$$N_2 = \frac{N_1 d_1}{d_2}\,\frac{(E + f_1)}{(E + f_2)}$$

The above formula, with slight variations appears in Prof. Goodman's applied mechanics. The writer does not know who first derived it; but it will hereafter be termed "Goodman's formula."

When power is transmitted by a belt it is thus evident from the above that creeping must occur between the belt and both the driving and the driven pulleys.

The number of revolutions made by the driven pulley is therefore not as great as usually determined by the commonly used formula

$$N_2 = \frac{N_1 d_1}{d_2}$$

Where no power is transmitted, no matter what the tension in the belt, there will be no creep. This is proved by experimenting with equal weights as suggested above.

If, for example, the same unit stress were used in steel belting as is ordinarily used in leather belting, the creep would be almost nil. Let us assume a case similar to Fig. 3, using the notations already given.

Let $f_1 = 0$ (This is obviously incorrect for steel belts but is used here because zero is used for leather);

$f_2 = 363$ lb. per sq. in. = unit tension on tight side;

$N_1 = 150$ r.p.m. = speed of driving pulley;

$d_1 = 120$ in.; = diameter of driving pulley;

$d_2 = 36$ in.; = diameter of driven pulley.

We are here assuming the thickness of the steel belt to be zero.

Then, substituting in Goodman's formula for the speed of the driven pulley: we get

$$N_2 = \frac{150\,(30{,}000{,}000)\,120}{30{,}000{,}363 \times 36} = 499.994 \text{ r.p.m.}$$

Neglecting elasticity we would use the common formula $N_2 = \frac{N_1 d_1}{d_2}$ and would get $\frac{150 \times 120}{36} = 500$ r.p.m.

The creep, $\frac{6}{1000}$ of one revolution, is small enough to be neglected.

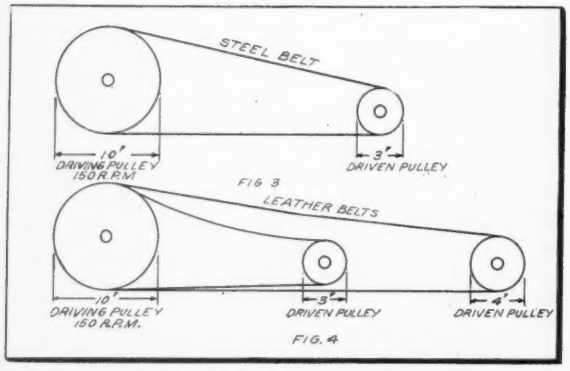


FIG. 3: STEEL BELT DRIVE

FIG. 4. DIAGRAM OF RIDER BELT ARRANGEMENT

In a single leather belt of 0.22 in. thickness the creep at a stress of 363 lb. per sq. in. is noticeable, namely

$$N_2 = \frac{150 \times 9000 \times 120.22}{9363 \times 36.22} = 479 \text{ r.p.m.}$$

Without creep the speed would be

$$\frac{150 \times 120.22}{36.22} = 498 \text{ r.p.m.}$$

The creep is therefore

$$\frac{498 - 479}{498} = 3.81 \text{ per cent.}$$

Assuming an allowable stress of 5000 lb. per sq. in. in steel belts, or even 10,000, the creep of such a belt would still be very small. Steel belts, therefore, have an advantage inasmuch as each per cent of creep represents about the same per cent of energy loss. This is true for the same reason that each per cent of slip in a belt causes one per cent of energy to be lost.

It must be remembered, of course, that this advantage is gained with a few attendant disadvantages such as higher tension, higher journal friction, greater shaft deflections and more wear. The ultimate superiority of steel over leather belts is yet to be proved.

Creep in Rider Belts

NO doubt a great many engineers, who have given it no serious thought, believe that in rider belts there is considerable creep between the outer and inner belts. Application of Goodman's formula, however, will show that there is practically no creep where the unit stress $f_2 = f_3$, where f_3 is the unit stress in the tight side of the outer belt. (See Fig. 4.) The diminution of stretch of the 2 belts will then be in unison while passing around the driving pulley, and the only creep will be that due to the slight differences in length, i. e., on account of the outer belt having greater circumference.

The dimensions of Fig. 4 are the same as Fig. 3, with the addition of a rider belt. We will assume that in the outer belt a stress of 318 lb. per sq. in. exists and that in the inner belt all conditions are exactly as before. Both belts are made of leather. The diameter of the pulley farthest from the driving pulley is 48 in. Then, letting N_3 represent the r.p.m. of the farthest driven pulley, the speed of the latter equals,

$$N_3 = \frac{150 \times 9000 \times 120.44}{9318 \times 48.22} = 364 \text{ r.p.m.}$$

Neglecting stretch in the belt, the speed would be

$$\frac{150 \times 120.44}{48.22} = 375 \text{ r.p.m}$$

$$\frac{375 - 364}{375} = 2.94 \text{ per cent creep.}$$

Computing the creep between the belts we get

$$\frac{3.82 - 2.94}{2} = 0.44\%$$

This is very small. No doubt the result is inexact because the creep of the inner will certainly influence the creep of the outer belt to some extent. Besides, it is difficult to conceive of an outer belt of this kind having less creep with respect to the driving pulley than the inner belt. It is the belief of the writer that the creep of the outer belt with respect to the driving pulley, will be greater than the creep of the inner belt, in most cases. The results of an investigation along this line would be interesting and perhaps valuable. Nevertheless, it is evident that if there must be a variance in the tensions of belt 1 or belt 2, it is best to maintain the highest tension in belt 1, rather than in the second and thus avoid excessive creep between the belts where friction is greatest.

ALTHOUGH RATHER an expensive floor, creosote or hardwood block laid end grain has been found by the Aberthaw Construction Co., in a recent investigation to have the advantage of resisting water, of standing up under the hardest trucking, of being a resilient, noiseless floor and one which can be kept very clean. Where these are laid over concrete, the best practice is to dip them in tar and stick them to the floor, then grout between the blocks with cement. A 3-in. block has sufficient depth.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

CONNECTING TRANSFORMERS AND MOTORS. II

Selection of Transformers for Motor Load

By A. L. Temple

IT is seldom advisable to use other than single-phase transformers for 3-phase loads in industrial plants. The advantages of the 3-phase transformer do not appear until large sizes are reached when they can be permanently located in substations or the generating station. The sizes of transformers are given in the Reference Table for the different sizes of motors. As a general rule it may be stated that the kv.a. capacity of 3 transformers for motor service should equal the horsepower of the motors connected in order to be on the safe side when both large and small sizes of motors are to be used on the same system and the power factor of the operation can not be controlled. It is well known that when an induction motor is running at its rated load it is operating most efficiently. When running at no load the induction motor draws a current of from 30 to 35 per cent of the full load a considerable part of which is known as wattless and pulls down the power factor of the system. It also loads up the generators and transformers with a current that does no useful work but heats the machines and transformers the same as the energy current. On this account it is advisable when installing transformers on a system where it is certain that a large number of small induction motors are to operate to have the transformers large enough to carry the wattless current that may be required. In such a case it will be good practice to install a transformer capacity of about 20 per cent greater capacity than the motor load. It is also necessary to install larger transformers by about 20 per cent if 2 transformers are to be used in open delta connection for 3-phase motor load. For other cases the values given in the Practical Reference Tables of this issue cover the sizes.

Wiring of A. C. Motors

LINE wiring of alternating-current motors is often guessed at or roughly computed in many cases especially from the supply circuit to the starter. Again it is often desirable to connect small motors without a starter and the question of running and starting fuses comes up. The Reference Tables based upon calculation and the mechanical strength of the best smallest size of wire to use in installing a.c. motors will be of service. The tables given need little explanation as they plainly indicate how they are to be used. It may be well to illustrate their use, however, through an example. Suppose a 10-hp., 3-phase motor of 220 volts is to be installed 100 ft. from the supply line. Referring to the table it is found that a No. 2 wire is the proper size up to the starter when a No. 6 can be used from the starter to the motor. The table is based on 1.25 volt drop in 100 ft. and a liberal starting current. Referring now to the table showing size switches for 220-volt motors, it is found that a 75-amp. switch is required for a 10-hp. motor. The starter is usually sent with the motor and will be of the proper capacity. If a starter is required for a particular motor the size of the motor and its nature whether single or 3-phase should be given the manufacturer and a starter ordered that suits the particular motor.

For distances greater than 100 ft. from feeders in industrial plants and for the calculations of long runs from the supply line, the formula given in the Reference Tables should be used instead of the values given in the tables which are for short distances only.

ELECTRIC MOTORS IN PARALLEL WITH STEAM ENGINES

By R. E. Neale

THERE are circumstances under which it is desirable to parallel mechanically an electric motor with a steam engine. For example, the engine driving a works may be heavily overloaded at certain times during the year, but may at other times and in all other respects be perfectly satisfactory. The difficulty having arisen, an economical solution can often be found by belting an electric motor onto the main lineshaft—mechanically in parallel with the previously existing engine. This course is not to be recommended for universal adoption; and, in particular, it should not be employed if some of the machinery can be isolated and driven exclusively by an electric motor.

In order that an electric motor and a steam engine may operate successfully in parallel, it must be arranged either that the motor cares only for a fraction of any peak load above the normal capacity of the engine, or that motor and engine share the total output at all times in strict proportion to their capacity. The former arrangement takes full advantage of the steam engine capacity, so far as this is adequate, and is, therefore, to be preferred in installation of the type considered.

By belting an induction motor to the main shaft, in such a pulley ratio that the motor runs at synchronous speed when the load on the main shaft is normal, it is secured that the motor runs light (consuming only magnetizing current) till the load on the main shaft rises above the rated capacity of the engine; thus slowing down the latter and, by permitting the induction motor rotor to slip, throws some of the surplus load on the electric supply mains. When the engine is overloaded, say 20 per cent, a total demand equal to about 1.6 times the rated full load capacity of the engine can be supplied, the electric motor then supplying 80 hp. in the case of a 200-hp. (normal) plant. The motor must not be switched in circuit

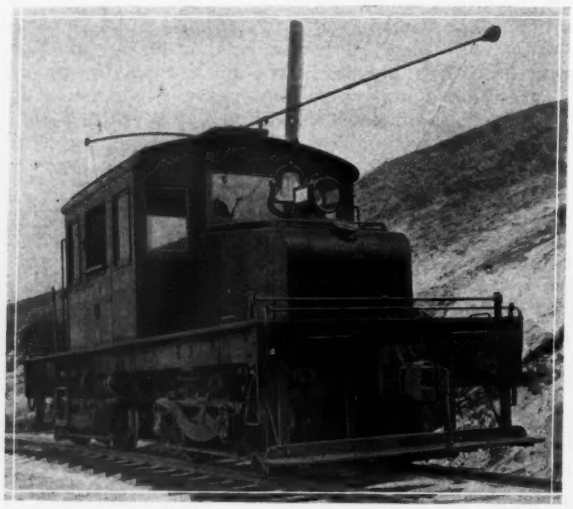
until the engine is up to speed, and it is necessary to prevent the motor being run at over synchronous speed, otherwise energy will be fed into the supply company's mains. The steam pressure and the motor supply frequency should be as constant as possible, and any necessary adjustments should be made at the engine governor, a close watch being kept on an ammeter in the motor circuit to determine when such adjustment is required.

If it be preferred to let the motor and engine share the total output at all times, it is only necessary to arrange that the percentage speed variation with load is the same in the 2 machines. The electric motor may be of any speed, so long as the ratio R of the lineshaft, to the motor-pulley diameter is R = (motor r.p.m./lineshaft r.p.m.).

By taking indicator diagrams from the engine and measuring the watts input to the motor, it is determined whether the ratio of division of the load between the 2 machines is constant under all values of the total load. If it is not, the engine regulation is made less close if the motor is underloaded or closer if the motor is overloaded.—The Power User.

ELECTRIC LOCOMOTIVE FOR ORE HANDLING

WITHIN the past few years, the applications of electric locomotives to many phases of industrial service has become very extensive. One of the many uses to which these locomotives have been put is for switching cars in a manufacturer's private yard, thus eliminating the switching charge made by system railroads, and also doing away with the fire hazard to the buildings and material in the vicinity.



FORTY-TON ELECTRIC LOCOMOTIVE USED FOR SWITCHING ORE CARS

Often a manufacturer is compelled to haul his raw material and finished product a considerable distance to and from his plant in order to connect with a steam railroad. One notable example of such a condition is that of a certain brass manufacturer who had to use 144 horses to haul his raw material and finished product a distance of one mile and a half before employing electric locomotives.

Locomotives for this service are economical power consumers, in view of the fact that slow speed motors are used which do not make excessive demands on the power house. Often, no additional generating apparatus is necessary to that already installed.

The Timber Butte Milling Co., Butte Mont., has recently put into service a 40-ton Baldwin-Westinghouse electric locomotive. This locomotive is being used for hauling materials to the concentrator site, and as soon as the concentrator is in producing operation, the locomotive will haul the concentrates to points on Montana Street, where switching connections have been established with the Chicago, Milwaukee & St. Paul, Northern Pacific, Butte, Anaconda & Pacific, and Great Northern roads.

The mechanical parts for this locomotive were built by the Baldwin Locomotive Works, Philadelphia, Pa. The electrical equipment, which is of the latest type for this class of service, consisting of 4 90-hp., 500-volt, commutating-pole motors especially designed to give good commutating at all loads found in normal service, and the unit switch control system was furnished by the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

REPLACING BATTERIES WITH MOTOR-GENERATOR

By J. C. Hawkins

IN all large buildings or groups of buildings that are used for office and other similar purposes a great many call bells, buzzers and private telephones are used. There is also a fire alarm system, watchman's clocks, burglar alarm system, elevator signal bells, and sometimes an electric time clock system throughout the buildings. These are as a rule operated by primary batteries.

In the group of office and scientific research buildings with which the writer is connected there is an exceptionally large number of fixtures which require battery current, and there has been in use at one time over 650 No. 2 Samson cells, 150 Gordon cells, and a large number of others. These of course are placed in groups of from 2 to 10 on a circuit as the size and number of bells require, and are located near the point where the current is used. The attention required to keep these batteries in good working order took nearly all of one man's time, and as they were located in so many places in the several buildings there was no one except the chief electrician, who had been in the place several years, who knew the location of all of them, and the wiring to the various bells. The cost of upkeep, the trouble that these batteries caused, and the addition of new bells all the time, made it necessary to devise some other scheme of furnishing current to them.

After thoroughly going into the matter it was decided to install a small motor-generator set to supply current in place of batteries. The set that was installed is a 115-volt, ¼-hp. Holzer-Cabot motor direct-current, direct connected to an 8 to 14-volt 15-amp. generator mounted on a slate slab, and running 1160 r.p.m. This set requires a floor space of 16 in. by 30 in., and is mounted on brackets on the wall back of the distribution switchboard. There is a one-panel slate switchboard mounted on the wall above the motor-generator set on which there is a motor starting box, a field rheostat, and a power switch. The current for the motor is taken from the 112-volt bus-bars of the distribution switchboard.

The generator is connected through fused cutouts mounted on this board to 5 circuits which lead to the various parts of the several buildings, and to the different bell systems. For instance, the fire alarm bells are on one circuit, the watchmen's clocks are on another, and the elevator bells, buzzers, call bells, etc., are connected to the same circuits, as they require about the same voltage. The voltage carried must be about 12 volts on account of the large gongs and fire alarm bells; this is too high for the small bells and buzzers, and it was necessary to insert a resistance in some of the circuits. This is generally located at such points that the minimum number of resistance coils will be required. The cables leading from the motor generator set are No. 12 duplex lead covered rubber insulation run in the conduits that are placed in the tunnels and walls. The extra conduits were put in place when the lighting system was installed.

The system has been in use only a short time, and no data is available at this time in regard to the operating cost; but a conservative estimate places the cost to operate, and care for the equipment, at less than 50 per cent of the former cost. As there are 2 large buildings located about 1800 ft. from the power plant, and as there are several large gongs that will require from 8 to 10 volts, it was not considered feasible to connect them to the existing system, for the voltage on the entire system would have to be increased too high for the bells in the nearer buildings in order to overcome the drop in voltage in the long line; so a second unit is to be installed, and regulated to carry a voltage of 15 to 18, which will give the required voltage for the large bells in the distant buildings. The second set could be installed in the distant building, but it is desirable to have them at the power plant where they will be under the care of the engineers at all times.

The cost of the system was, motor-generator set, including starting box and rheostat, $100 each, wiring in nearby buildings, including labor, $145; wiring to distant buildings, including labor, $108; the total cost including the second generator set will be not over $560. The batteries in use at one time to operate this system cost about $540. The system is giving excellent results so far, and requires little attention after the voltage is once regulated. All the work was done by the regular force of electricians employed in the building under the supervision of the chief engineer.

STEAM METERS*

Report of the Steam Meter Committee at the Convention of American District Heating Association

IN considering defects in meters, we have considered 2 types of condensation meters, one the revolving type and the other the dumping type. C. H. Spiehler, a member of the committee, having had considerable experience with the revolving type, enumerates his troubles as follows:

The greatest trouble with the revolving type of meter seems to be that the bearings become tight, consequently the drum ceases to revolve. It is then necessary to dismantle the meter, clean the bearings and pins, and lubricate them.

It seems there is still considerable room for further improvement by the manufacturers in the bearing design. Some method of constant lubrication seems to be an absolute necessity.

Another trouble with this class of meters is that the dial glass often becomes covered with moisture on the inside and it is impossible to read the dial. It has often been found necessary to remove the dial glasses from meters of this type and in such a case an unscrupulous customer might misplace the hands. There has also been, in some cases, difficulty from the hands slipping on their supports, thus giving an incorrect registration. These difficulties should be overcome in some way.

A third difficulty in this type of meter is that of cleaning the drums. The manufacturer, however, gives a formula for cleaning solution as follows:

Where exhaust steam is used with no oil separators on the line, a greasy deposit is sometimes found on the drums and this can be removed by immersing the drum in a solution consisting of: 1 gallon sulphuric acid, 1 gallon nitric acid, 1 gallon water, 1 pound table salt.

The spout should also be cleaned with this solution.

Turning now to the faults of the dumping type of meter, the following suggestions are made by G. D. Higgins, of Detroit, who has had considerable experience with them. He states:

(1) More clearance should be given to the dash pots so as to prevent interference.

(2) A rivet is now soft soldered to the side of the bucket so as to operate the counter. This frequently breaks off and should be fastened more securely.

(3) The horse shoe on the back of the dial is soft soldered and comes loose. It should be fastened on better.

(4) There is trouble with bearings. There being very little movement of cones, the balls, cones and cups wear so that the meter sticks and becomes inaccurate.

As above mentioned, the principal defect in the case of the St. John meter is the liability of the clock work mechanism which revolves the paper recording chart to get out of order, due to temperature conditions. This is, perhaps, unavoidable on account of the delicacy of the mechanism. The ordinary St. John meter has a glass case over the clock work mechanism to protect it. This being made entirely of glass is very frequently broken and it has been found advisable to make a metal case with a piece of glass fitted into the end, so that one can see whether the meter is registering properly. It has been found that this meter will not record accurately when operating at relatively low capacity, (at perhaps 15 per cent of the maximum for which the meter is designed) as the tapered valve sometimes shows a tendency to pound and hammer on the seat.

Care of Meters

ONE of the meters described in the report of last year is that manufactured by the General Electric Company. The General Electric Company has issued various pamphlets and printed matter describing this meter, and their Instruction Book No. 8546 gives a detailed explanation of the meter and its method of

*(An outline of this report was given in the June 15 issue of Practical Engineer in connection with an account of the convention. There was so much valuable information given in the report, however, that the present abstract, dealing principally with the practical side of meters, is published for the benefit of our readers. Editors.)

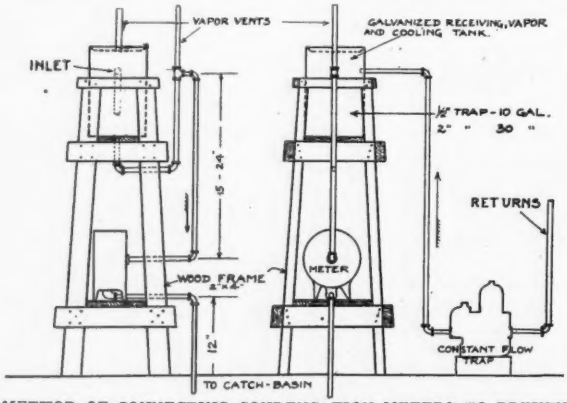
operation. The following rules, however, may be of some assistance to those who are using this type of meter:

These meters are provided with a dust case which it is only necessary to open when changing the chart, which in the case of the standard meter having a clock feed of 3 in. per hour, will last about one week.

This clock has an eight-day movement, winding from the outside of the case, and should be wound about twice a week.

Three grades of ink, containing different amounts of glycerine, can be ordered with the meter. The higher the temperature of the air surrounding the meter, the more glycerine is desirable in the ink. As the ink in the trough evaporates, water should be added occasionally rather than fresh ink. Addition of water will prevent the ink from drying in the pen.

Steam which contains a large amount of foreign matter may tend to clog up the nozzle plug, which should be blown out as often as necessary. The majority of installations never require blowing out of the nozzle plug. In others it is necessary to blow out the



METHOD OF CONNECTING CONDENSATION METERS TO PREVENT SURGING AND SPINNING

plug about once a month. This can either be done by opening the by-pass valve above the meter and blowing out the nozzle plug through the holes in the top of the reservoirs, or through the plugs at each end of the by-pass valve, in case the pipe itself needs attention.

In the case of the meter having an automatic pressure correction, do not allow the pressure gage to fluctuate rapidly, as this excessive amount of work on the gage spring will cause it to deteriorate.

The valve in the pipe line to the pressure compensating gage spring should be throttled the same as in the case of a steam gage which contains a spring of the same material.

The idler pulley rests on the inside of the back belt and must not be placed upon the outside of the front part of the belt. If the belt tends to tear the paper at the pins on the drum, slightly stretch it. If the belt does not give sufficient tension to prevent the paper from touching the meter base when the re-roll spool is nearly full, slightly shorten the belt by sewing with fine thread. This increases the tension.

In case it is desirable to verify the reading of the instrument, proceed as follows:

Remove the adjustable weight from the balanced vertical lever carrying the pen arm by lifting it to the top of the lever where it can be readily removed. Unhook the horizontal top lever at the small end and note if the pen remains in any position on the chart to which it may be moved. If it does not, the adjustable weights above the knife edge which balance this part of the instrument should be adjusted accordingly. With the horizontal lever unhooked, the tops of the 2 cups containing mercury should be at the same height; if they are not, adjust the large weight at the bottom of the left-hand cup, replace the weight on the last arm, and by means of the nut at the left-hand end of the upper horizontal lever, adjust the instrument so the pen reads zero on the chart, first connecting the hook at the right-hand end of the horizontal lever to the arm support carrying the pen. As a further check on accuracy, note the pen deflection obtained by connecting a glass tube to the right-hand pipe of the meter, pouring water in the tube. Curves furnished with the instrument show the correct deflection against water column for various settings of the compensating weight.

Care of Condensation Meters

MR. Spiehler gives the following experience in regard to the care of condensation meters of the revolving type: He says:

"For the past 2 seasons we have been making daily inspections and readings of all installations which require a size F meter or larger and find that it more than pays. On all other installations, inspections and readings are made weekly.

For lubricating the bearings, we use a mixture of cylinder oil and graphite. On the larger installations where the condensation is not cooled before passing through the meter, the bearings are lubricated weekly; on all other installations, monthly. Wherever possible, meters are so installed that they can be readily tested on the customer's premises without being disconnected. The tests are made upon the customer's request, or for the company's information.

To obtain the best results in every particular, it is necessary that the steam put into the mains be absolutely clean and that the condensation be cooled as low as possible before entering the meter.

Up until last season, this company experienced all sorts of difficulties—radiators and return pipes become partially filled with a deposit, air vents plugged up, likewise traps and meters, the different heating systems would become flooded with water and leak out of air vents and damage floors and ceilings. Complaints rolled in thick and fast and kept several men busy keeping the different systems in running order. All this trouble was due to the feed water and to the cylinder oil in the exhaust steam. The feed water was taken from a canal which was extremely dirty (suspended clay and organic matter) and averaged about 16 grains of scale forming solids per gallon.

A water softener and filter was installed and the steam taken from turbine exhaust and now it is a rare occurrence when a meter or trap becomes plugged up. We have also observed where the condensation is well cooled, that our meter trouble is greatly lessened.

Every summer all meters are removed to the company's shop, cleaned, repaired, tested, painted and then reset. All traps are cleaned and necessary repairs made at this time.

Another suggestion as to the care of meters is incorporated in the accompanying sketch which we will call Fig. 1, which shows the methods adopted, with some modifications, by several companies for connecting up these meters on return lines of heating systems or restaurants. The principal feature of this arrangement is the galvanized iron receiving tank with vapor vent which is found to be necessary in

order to prevent the surge of water or steam into the meter and the consequent spinning of the vanes. This tank serves to cool the condensation before it overflows into the meter.

Further suggestions as to the care of meters from Mr. Redfield of the Central Station Steam Company are as follows:

(1) Oil separators should be installed at various points of the line to keep oil from depositing on the meter drum and bearings.

(2) A screen, or strainer, should be installed in front of each trap and meter to catch the core, sand and other dirt from the radiators and pipes and keep it out of the traps and meter. This screen, of course, should be frequently inspected and cleaned.

(3) Every spring the meter should be brought back to the repair shop and bearings and counter cleaned with kerosene or gasoline. The meter bearing pins should be coated with graphite paste before replacing.

(To be continued.)

POWER PLANT CHEMISTRY

Analysis of a Gas Sample

HANG the instrument on a nail, using the hole, H3. Remove the plug from the air-vent, and the leveling bottle, L, from its compartment in the instrument case. Draw the potash up by means of L into the curved capillary tube above the CO_2 chamber. Replace L and connect the rubber aspirator tube with the nipple of the gas cock at the top of the instrument. You will note that there is a pump bulb on the aspirator tube; also a soot filter,—the latter being provided with a half-inch rubber connection for attaching to any metal tube through which the gas is to be taken for analysis. Having made the proper connections, set the lever of the cock in a horizontal position pointing towards you. Work the pump bulb with the hand and gas will flow through the burette and bubble out at the leveling bottle.

When satisfied that you have exhausted the air from the tube and connections and have a fair sample of gas in the burette, remove L from its compartment and hold with the left hand against the instrument case near B. Hold L in such a position that the surface of the water in the bottle will be on a level with the zero mark on B. With the right hand move the lever of the cock to the vertical position. This opens an air vent in the cock and allows the surplus gas to escape and the water flows into B from L. Keep the surface of the water on the zero mark by slowly raising L as the water flows from it into B. You will see that the surface of the water in L has a curved appearance. When the bottom of the curve or meniscus, as it is called, reaches the zero mark, move the lever of the cock to the horizontal position, pointing away from you. This locks the measured gas sample in B. You have measured the gas at atmospheric pressure and at the temperature of the water in the jacket J. When you can make this measurement correctly, you have mastered the most difficult thing that you will meet.

Do not run the water above the zero mark when taking the reading, as this will expel too much gas and spoil the sample.

When reading the burette, get the eye down into the same horizontal plane as the water levels.

Next, squeeze the clamp, PC1, open with the fingers of the right hand and raise L. Water will flow from L into B and rush the gas across into the potash chamber through the connecting rubber tubes. As the potash level falls, the steel wool fibers with which the potash chamber and glass tube above it are packed, will be left wet with the solution. The gas flows over these wet fibers and is stirred and mixed as it filters through them. Every particle of the gas comes in contact with the potash-covered fibers and the CO_2 is instantly and completely absorbed. Raise L until B is completely filled and the water pinches out in the capillary tube at the top.

Next, lower L and bring the gas back into B. Watch for the potash to appear in the glass tube above the potash chamber. Bring the gas back slowly and snap the clamp shut when the potash reaches the curved capillary tube.

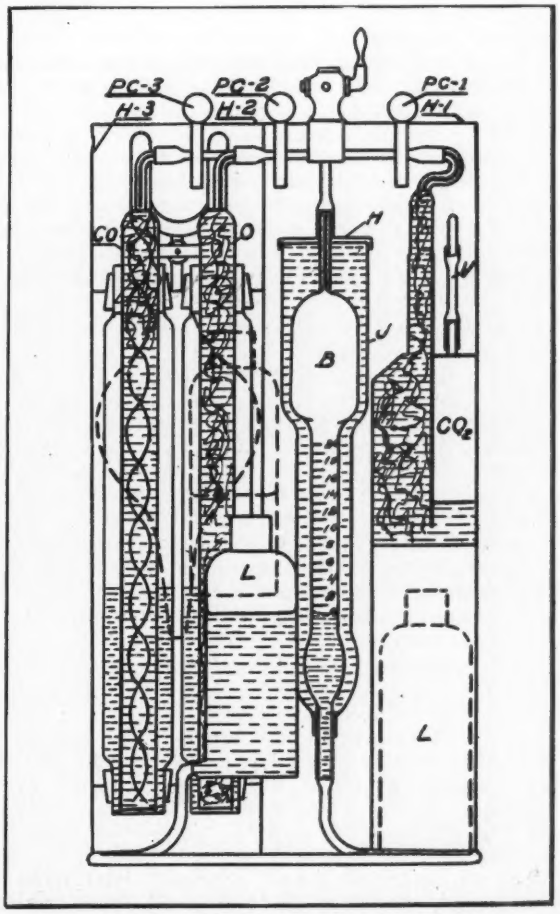


DIAGRAM OF HAYS GAS ANALYSIS INSTRUMENT

When passing the gas over, watch the water in the burette. When bringing the gas back, watch the potash. After bringing the gas back and closing the clamp, hold L in such position that the surface of the water will be on the same level as that in the burette. Read the scale

under the meniscus, making sure that your eye is down in the same plane as the water levels. When taking this reading the water levels must be in the same plane, wherever that plane happens to be.

The scale reads directly in percentage of CO_2. It is calibrated in fifths of per cent, but in writing down the reading it will be most convenient to use decimals. For example, instead of writing 12 3/5, write 12.6.

To determine the percentage of oxygen, it is necessary first to remove the CO_2, and to determine CO it is necessary first to remove both CO_2 and O. The cuprous solution for CO will absorb all free gases and pyro will absorb both O and CO_2. To determine O and CO, proceed with the gas residue remaining after the first absorption. First, turn the screw clamp at the rear of the O and CO tubes. Next, see that the liquids are drawn up into the capillary tubes at the top of the O and CO absorption tubes. Use the leveling bottle and if impossible to raise the liquids to the proper height, remove the glass plug in the rubber expansion bag. This will permit a small quantity of gas to enter the bag and the liquids will rise readily to their places.

The O and CO liquids are affected by air as they are both absorbers of oxygen. Hence, the use of the expansion bag, which prevents the absorbers from coming into contact with air as the liquids are pumped up and down.

Do not neglect to replace the plug in the rubber bag as soon as you have brought the liquids to the proper levels, and before proceeding with the analysis. If impossible to raise the liquids, see if the rubber tubes have been flattened and closed by pressure of the screw clamp. If this is the case, squeeze into proper shape with the fingers. If, at any time, you are unable to pass the gas from the burette, it will be due to flattened rubber tubes. Slip the clamps off the tubes by squeezing open and pulling upwards. Work the rubber tube with the fingers until the tube opens.

The O and CO absorptions will require about 5 min. each. After exposure to the oxygen absorber, return the gas to the burette and note the reading. Return again to the absorption tube. The process of absorbing and measuring must be continued until contraction of the gas ceases and the reading becomes constant. Proceed in exactly the same manner to determine CO. You will of course, use the clamp, PC2, when working on the O absorption and PC_3 when working on the CO.

Suppose that after the CO_2 absorption the reading is 14 per cent, after the O absorption 20 per cent, and after that for CO 20.6 per cent. The result of the analysis would be as follows: CO_2, 14 per cent; O, 6 per cent; CO, 0.6 per cent.

When drawing the gas back from any one of the absorption chambers, return it slowly and do not raise the solution too high in the capillary tube or you may draw some of it over into the burette. The acid, recommended to be used in the leveling bottle will neutralize any chemicals so drawn over and no harm will result. It is better for many reasons to use clear water and omit the acid, changing the water in the leveling bottle and washing out the burette when any solution is drawn over. Keep the instrument clean. If crystals form about the connections, wipe them off as they will attack and ruin the rubber.

The above instructions, followed carefully, will give results which enable the operator to check his work and determine whether or not the efficiency of his furnace can be improved. The effects of various defects in boiler settings and furnace operation as detected by an analysis of the flue gases will be discussed in subsequent issues.

FOREIGN DEVELOPMENT IN THE POWER PLANT FIELD

Choice of Arc Lamps or Lamps with Metallic Filament

By J. H. Blakey

SOME time ago a German firm published a pamphlet in which a comparison was made between arc lamps and lamps with metallic filament. While recognizing the superiority of the latter for domestic lighting, they would not admit that they could supplant arc lamps of great luminous intensity, ranging from 250 to 1250 candle power. They claimed that the arc lamp gives a light most nearly approaching sunlight, while incandescent lamps modify colors, which is a disadvantage in the lighting of stores and warehouses, on account of the choosing of materials and clothing by customers. A comparison was also made of the cost of lighting by the 2 systems, taking as standard a luminous intensity of 2500 candles for 1000 hr.; from this the conclusion was drawn that metallic filament lamps require an expense of energy of 0.9 watt per candle, while the energy consumed by the arc lamp is never greater than 0.7 watt. The pamphlet concluded by stating that the superiority, consequently, always remained with the arc lamp for high power lighting.

The German review "Licht und Lampe," having reproduced the comparative study given by the pamphlet, gives publicity also to the reply of the Societe Auer, which is an argument in favor of incandescent lamps with metallic filament of from 250 to 1250 candle power, such as the Osram lamp.

The reply first opposes to the statements made in the pamphlet the advantages possessed by metallic filament lamps in their steadiness and equality of distribution, which approach that of daylight. With them the costly and annoying changing of the carbons is done away with. By disposing in a judicious fashion a number of incandescent lamps at a suitable height, a light is obtained, with a smaller candle power, which is equal to or of greater intensity than that from a single arc lamp; moreover, there is not the injurious effect upon the eyes which is produced by the latter when placed at a slight elevation, as in the case of a store window. The Societe argues that when the 2 systems are compared, the comparison of expense based solely upon the number of watts of energy consumed per candle, does not lead to practical results. It draws attention to the fact that the pamphlet, in its comparison, deals only with arc lamps of the highest efficiency; from which the conclusion may be drawn that all other arc lamps are less advantageous than metallic filament lamps. In the Deutscher Kalender fur Elektrotechniker, Uppenborn indicates for ordinary alternating-current arc lamps with pure carbon, an expense of 0.85 to 1.75 watts per candle per thousand hours, an expense greater in every case than that of the most recent metallic filament lamps. It is true that certain alternating-current arc lamps with prepared carbons consume only 0.2 watt per candle, but these are only lamps of great intensity, of 12 amp. and upwards; it is not possible with other lamps to obtain so small an expense.

It is only for lamps having a minimum luminous intensity of 5000 candles that arc lamps are preferable; it may be admitted that they are sometimes more practical in street lighting, but even here an equal amount of light can be obtained with less expenditure of en-

ergy by the use of a number of Osram lamps. Further, the cost of maintenance, in the ease of the arc lamps, given in the pamphlet in question, is less than the real cost, especially if account is taken of the breaking of globes and interior glasses. The valuation of the duration of the Osram, which is put at 800 hr., is equally incorrect, as this more nearly approaches 1200 hr.

In the Electrotechnischer Zeitschrift for 1912, the engineer Vieweger arrives at the conclusion that in future very few arc lamps will be employed for street lighting, and that lamps with metallic filament will be used almost exclusively. According to the Electrical Times of July, 1912, an inquiry had been made as to the best method of lighting a railroad, in which arc lamps of 12 amp. were put into competition with metallic filament lamps of 625 candle power, 29 votes were given in favor of the latter, and only 4 in favor of arc lamps. The metallic filament lamps were preferred on account of the clearness and regularity of the light, and because of the absence of heavy shadows, which permitted objects along the right of way to be readily distinguished.

It may be remarked, with regard to the metallic filament lamp, that the luminous power increases with the temperature of the filament, whereas the duration of the lamp is approximately in inverse proportion to this temperature; consequently it is desirable to attempt to reconcile, as far as possible, these 2 conditions.

The author of the article, in summing up the controversy, believes that since the advent of recent inventions in the domain of electric lighting, the arc lamp has no longer, as formerly, the monoply of high power lighting, and that it may often be advantageously replaced by lamps with metallic filament. Each case, however, must be decided on its merits, but the fact remains that metallic filament lamps are now being used extensively where formerly only arc lamps were considered suitable.

LEAKAGE IN COMPRESSED AIR LINES

Practical Methods of Testing Leakage in Shop Lines

By William D. Ennis

COMPRESSED air transmission of power may be highly efficient. In the experiments at Paris, 1889, the whole loss by fall of pressure in 3 miles of mains was estimated to be about 2 per cent. The loss by leakage in a small air system such as is commonly used in engineering shops, may, however, often greatly exceed this figure. To investigate this point the writer has made direct measurements of leakage in a number of plants. The plan of procedure was as follows: Just before the noon hour the various consuming outlets were tightly closed, the pressure run a little higher than normal, and the compressor shut down. Beginning at the moment when the pressure fell to normal, gage readings were taken at intervals of 1 to 10 min., showing the pressure in the line. In very few cases was it found necessary or desirable to continue these tests for more than 60 min.

By shutting off parts of the pipe system from the main line, separate observations were taken of the fall of pressure in such parts. In order that such records

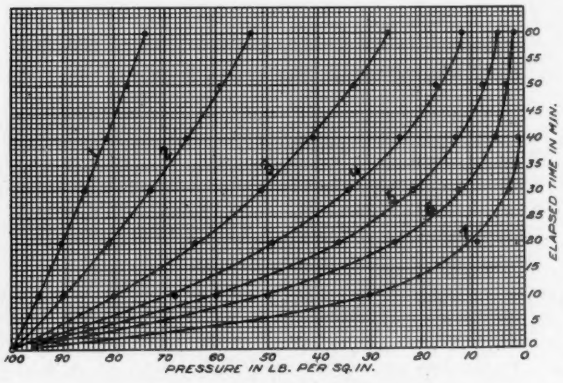


FIG. 1. AIR LEAKAGE CURVES

might be obtained frequently and without interruption to the regular service of the plant, a number of cut-off valves and gages were installed; the general plan being to isolate each building or department of the works. By providing a sufficient number of observers, the various departments could be tested at once.

With constant discharge (atmospheric) pressure and constant area of leaking orifices, the fall of pressure in a given time should be about directly proportioned to the pressure in the line. Based on this principle, the curves of Fig. 1 have been drawn. The 7 curves represent various rates of leakage, starting from 100 lb. initial gage pressure, the drop of pressure being 1 lb. during the first minute for curve 1, 2 lb. for curve 2,

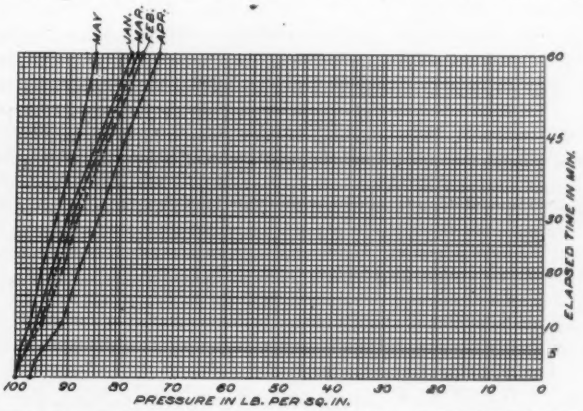


FIG. 2. AIR LEAKAGE IN A SECTION OF A CARPENTER SHOP

and so on. These curves are plotted merely to obtain a general notion of how the pressure should be expected to decrease in the dial tests.

Figure 2 shows similar curves obtained by tests of an actual pipe line, made once each month for 5 months. The contents of the line were 3 cu. ft. and the aggregate area of valved outlets (valves tightly closed during the tests) about 1 sq. in. The curves correspond closely with No. 1 of Fig. 1.

Figure 3 gives 3 curves, approximately of the type 2 (Fig. 1) class. Here the system was of 144 cu. ft. capacity with 46 sq. in. of aggregate outlet area. Carrying the investigation a little farther, Figure 4 gives 2 records for the entire plant of which the system recorded in Fig. 2 formed a part. Here the curves are apparently of the type 5 class. The cubic contents of the line were 1305 cu. ft., with 221 sq. in. of aggregate outlet area.

Another large system, of an inferior type, is represented by Fig. 5. The cubic contents were 916 cu. ft., the aggregate outlet area 246 sq. in.

The rate of pressure drop in these experiments showed no direct relation with the ratio of aggregate outlet area to volume of pipe line. It is inferred, therefore, that the number of hose connections or other orifices does not seriously influence the leakage; hence, that leakage in general occurs elsewhere than at the consuming valves.

Meaning of Pressure Drop in Terms of Air Loss

IF no change of temperature occurs, the weight of air in the pipe line is directly proportional to its pressure. A 10 per cent drop in (absolute) pressure therefore, means a 10 per cent loss of air, by weight. In

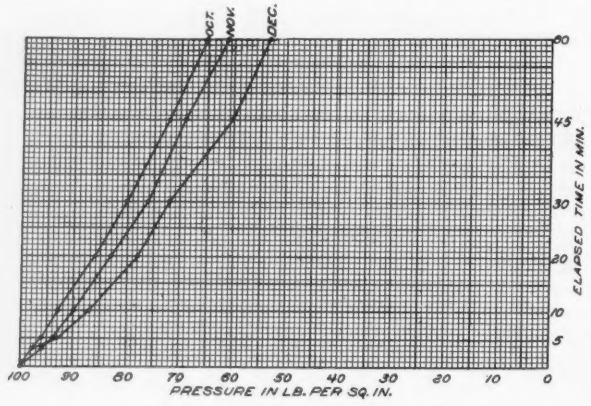


FIG. 3. AIR LEAKAGE IN BOILER SHOP

Fig. 4, nearly 20 per cent of the air was lost in 5 min., in Fig. 5, about 25 per cent. This was with the compressors shut down.

The compressed air capacity of a plant is expressed in terms of the free air, or air at atmospheric pressure, which the compressors draw in on their suction strokes. A cubic foot of free air represents a nearly definite weight of air—about 1/12 lb. The percentage loss by leakage, expressed in terms of weight, will therefore answer equally well for the percentage loss of equivalent free air contained in the pumped up pipe line. But

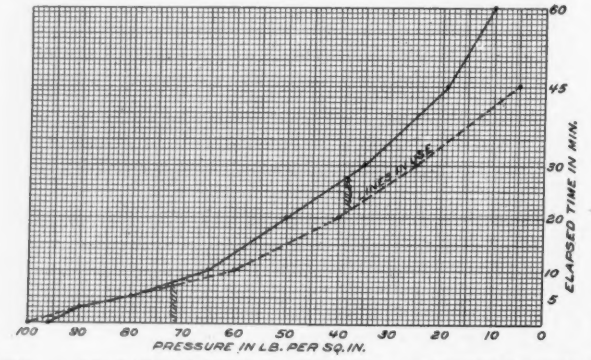


FIG. 4. LEAKAGE IN ENTIRE SYSTEM OF A CARPENTER SHOP

this percentage tells us nothing of the proportion of leakage loss under running conditions. We may assume that the actual amount of loss while running, is the same as that determined in the tests. It remains to ascertain what amount of air is being compressed and is flowing through the pipe lines under ordinary running conditions. A given pressure curve will of course indicate greater loss as the system is larger and the discharge through the system therefore, becomes less in proportion to its size.

The approximate compressor rating in the plant represented by Fig. 5 was 4000 cu. ft. of free air per min. Taking the percentage of pipe line contents lost in 5 min. at 25, there leaked out $0.25 \times 916 = 229$ cu. ft. of high-pressure air each 5 min. To reduce this to its approximate free air equivalent, we multiply it by the rates of its pressure to the atmospheric pressure of free air, both being expressed as absolute pressure, that is, by $\frac{100 + 14.7}{14.7} = 7.83$. This gives $7.83 \times 229 = 1790$ cu. ft. of free air lost by leakage in 5 min., or $1790 \div 5 = 358$ cu. ft. in one minute; which is $358 \div 4000 = 0.0895$ or nearly 9 per cent of the average amount of air pressing through the line.

Similarly, in Fig. 4, with 2800 cu. ft. of compressor delivery per minute, the leakage was $0.20 \times 1305 = 261$ cu. ft. of high-pressure air, or $261 \times 7.83 = 2050$ cu. ft. of free air, per 5 min. beginning at 100 lb. pressure. The proportion of loss was then $(2050 \div 5) \div 2800 = 0.1462$ or 14.62 per cent.

These results are particularly bad, but losses above 5 per cent are rather common in the ordinary mill plant. A 5 per cent loss of free air means, of course, a 5 per cent waste of power expended in air compres-

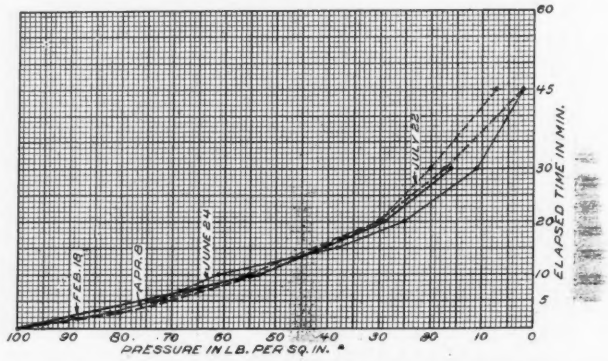


FIG. 5. CURVES SHOWING EXCESSIVE LEAKAGE

sion. In some of the Paris street installations already referred to, the rates of leakage loss were much less, as indicated by the following data:

Results from the Paris System

THE diameter was 11.76 in., or 0.98 ft., giving a cross-sectional area of $0.7854 \times 0.98^2 = 0.755$ sq. ft. Tests were made on 6 sections, as below. Southern section, first half initial pressure, 77 lb. gage; pressure after one hour, 55 lb.; loss, 22 lb., or 24 per cent of the initial absolute pressure in one hour. This groups the section in class No. 1 of Fig. 1. The length of the line was 5.69 miles or 30,000 ft., so that the volume of air contained was $30,000 \times 0.755 = 22,650$ cu. ft. Reduced to free air, this becomes approximately 141,500 cu. ft. and the loss of free air per hour by leakage, was $0.24 \times 141,500 = 33,800$ cu. ft. The maximum flow in the pipe was about 600,000 cu. ft. of free air per hour, so that the percentage of leakage loss under running conditions was $33,800 \div 600,000 = 0.056$, or 5.6 per cent. The great length of line made the carrying capacity relatively less in the case of the mill plants referred to, so that the proportions of loss by leakage is large even though the amount of leakage (expressed in terms of pressure drop) is small.

Southern section, entire line: initial pressure, 79½ lb.; pressure after one hour, 57½ lb.; loss, 22 lb., or 23½ per cent.

Length of line, 10.69 miles = 56,400 ft.

Volume of air in line, 56,400 × 0.755 = 42,500 cu. ft.

Volume of free air in line, 271,000 cu. ft.

Loss of free air per hour, 271,000 × 0.235 = 63,800 cu. ft.

Percentage of leakage loss, 63,800 ÷ 600,000 = 0.106 (10.6 per cent).

Central section (part):

Initial pressure, 84 lb.

Pressure after one hour, 76 lb.

Loss of pressure, 8.4 lb. = 8.5 per cent.

Length of line, 5.69 miles = 30,000 ft.

Volume of free air in line, 141,500 cu. ft., as for the first half of the Southern section.

Loss of free air per hour, 141,500 × 0.085 = 12,000 cu. ft. air delivered through line per hour, 600,000 cu. ft. (free).

Percentage of leakage loss = 12,000 ÷ 600,000 = 0.02 (2 per cent).

For the remaining sections tested, the final results were as follows:

	Entire Central Section	Northern Section	Pyrenees Section
Length in miles	10.69	0.87	0.34
Loss of free air, per hour, cu. ft.	59,000	2100	782
Percentage (absolute) pressure drop in one hour	21	11	11½
Percentage of total flow lost by leakage	9.7	0.35(a)	0.13(a)

The low figures marked (a) are due to the shortness of the lines, so that the absolute leakage was small in relation to the volume of air flowing.

Effect of Leakage on Power Consumption

THE power expended in compressing that portion of the air which escapes by leakage before reaching the point of application is wholly wasted. The percentage of power lost varied, in the Paris experiments, from 0.13 to 10.6; having a more or less direct relation to the length of pipe line, because the volume of flow is limited by that length. For lengths between 5 and 11 miles the percentage of power loss was 2 to 10.6. In 2 of the mile plants represented by the curves here presented, the corresponding losses were 9 and 14.6 per cent. With standard workmanship on the pipe lines, the percentage loss of air and power might be expected to increase as the size of the system increased. That it actually does so is evident from the low losses tabulated from the Northern and Pyrenees sections at Paris.

The Paris results therefore indicate a far better standard of pipe line construction and maintenance than are common in average mill plants of today; and the latter construction shows greater variations in excellence than should be tolerated.

In all of the tests, the fall of pressure was in part due to the accidental opening of valves or operating of small motors when the line was supposed to be sealed. This means that the loss was due not only to leaky gaskets and threaded joints, but also to careless supervision. From a power standpoint, however, all of the loss is leakage. The difference is that part is to be corrected by better workmanship on and attendance to the pipe joints, and part by more adequate supervision.

Depending on the type and efficiency of compressor, from 3 to 6 cu. ft. of free air may be compressed per minute for each indicated horsepower of engine capacity. Taking the leakage loss from Fig. 4 (pipe line contents, 1305 cu. ft.) as 410 cu. ft. of free air per minute, the amount of waste was not far from 100 hp. This waste goes on as long as pressure is maintained in the line, regardless of the demand for air. The illustration is an extreme one, but the loss is in all cases serious. If we retain the ratio 4.1 cu. ft. free air per minute per horsepower, the losses for all of the cases considered are as follows:

Fig. 5, $358 \div 4.1 = 87$ hp. (916 cu. ft.)

Paris (a), $\frac{33{,}800}{60} \div 4.1 = 137$ hp. (5.69 miles = 22,650 cu. ft.)

(b), $\frac{63{,}800}{60} \div 4.1 = 258$ hp. (10.69 miles = 42,500 cu. ft.)

(c), $\frac{12{,}000}{60} \div 4.1 = 47$ hp. (5.69 miles = 22,650 cu. ft.)

(d), $\frac{59{,}000}{60} \div 4.1 = 240$ hp. (10.69 miles = 42,500 cu. ft.)

(e), $\frac{2100}{60} \div 4.1 = 8\frac{1}{2}$ hp. (0.87 miles = 3455 cu. ft.)

(f), $\frac{782}{60} \div 4.1 = 3.2$ hp. (0.34 miles = 1350 cu. ft.)

A low price for a horsepower is 3 cents per hour. The needless loss due to air line leakage may in a large works be easily above $1 per hour.

Some Conclusions

THE percentage of (absolute) pressure drop represents nearly the percentage of pipe line contents lost by leakage. This percentage, with constant (atmospheric) discharge pressure, varies directly with the "area" of leaks and inversely with the size (cubical contents) of the pipe line. Tests show it to be usually greater for entire systems than for isolated parts thereof. Consequently, as parts of a system are thrown together, the area of leaking orifices increases more rapidly than the system volume. That is to say, the leakage occurs principally at main line points rather than at outlet valves.

The percentage loss of power and of compressor capacity varies directly with the observed pressure drop and inversely with the volume of air being delivered through the line. It therefore increases rapidly with the length of the line and is greater for whole systems than for parts thereof. It commonly exceeds 5 per cent in large mill plants and the greater part of this loss may be easily avoided by better pipe fitting. The waste goes on as long as pressure is maintained in the line, and is subject to practically no fluctuations. If air were as visible as steam, the leaks shown to exist would probably not be tolerated.

INSTALLATION OF A transmission line is to be made from the Mira Flores Power Plant to the east of Gold Hill on the Panama Canal, to furnish power for the operation of 2 relay pumps on the west bank, 2 relay pumps on the east bank, and 2 booster pumps north of the hill. These pumps are to be used in dredging operations in the Culebra cut, and the booster pumps for hydraulic work back of the hill. At one place the 3 conductors which are of No. 00 wire will be swung across the cut at a height of 345 ft. above sea level and will be carried on steel cables having the ends firmly secured. The transformers for this line have been ordered from the Allis-Chalmers Co., and have a total capacity of 1500 kw. at 6600 or 11,000 volts transmission from a primary voltage of 2200 and at 25 cycles per second.

THE ILLMER GAS ENGINE

A Double-Acting Machine Operating on a Two-Stroke Cycle

IMPERFECTIONS disclosed in the pioneer 2-stroke engines, such as improper charging of the power cylinder, low mechanical efficiency due to excessive pump work, and complication on the pumping side of the engine, have been eliminated in more recent designs. In Europe, cylinders of fully 2000 b.hp. capacity have been in successful operation for some years, and, in view of the satisfactory results attained, marked activity is now manifest in the application of the large engines of this type.

For a full realization of the profits afforded by the superior fuel economy of the internal combustion engine, reliability of operation is indispensable. The question of prime importance in the selection of a gas engine is, therefore, one of simplicity of construction and reliable operation. In this connection it is to be remembered that the pump parts of a 2-stroke engine are continually working at low pressure and involve no difficulties of design or construction. High temperatures and pressures are confined solely to the power parts.

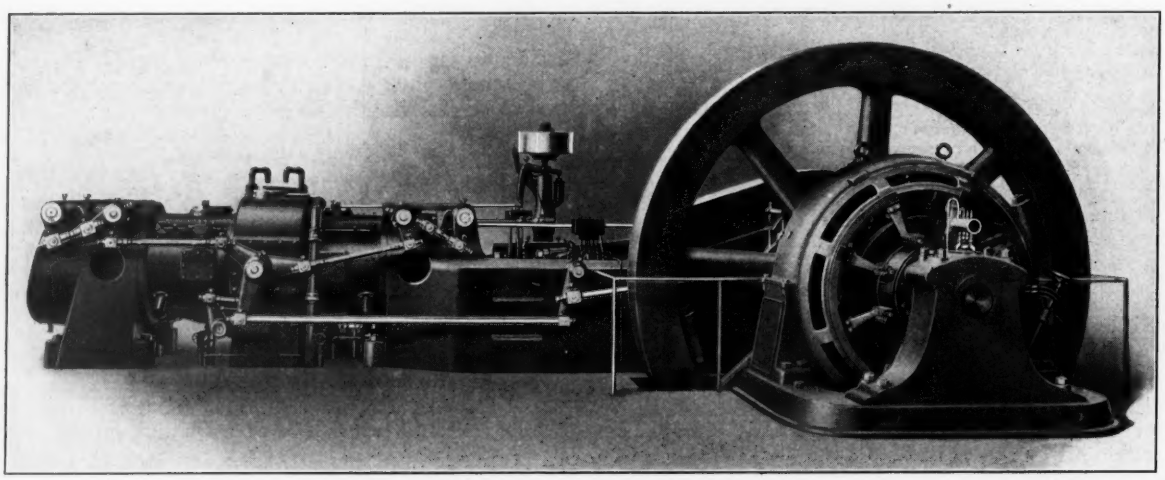


FIG. 1. GEAR SIDE OF ILLMER GAS ENGINE

The 2-Stroke Cycle

IN the 2-stroke cycle, the power cylinder is usually provided with exhaust ports which the piston uncovers as it approaches the end of its expansion stroke. During the time that the exhaust ports are open, an auxiliary pump forces into the power cylinder, first, a stratum of scavenging air, which is immediately followed by the explosive mixture body. After thus charging the power cylinder, the exhaust ports are again covered by the return of the piston, and the working charge is compressed. At the instant of maximum compression, the charge is fired by means of an electric spark and the piston driven forward under the resulting explosive pressure until the end of the expansion stroke is reached, when the exhaust port is re-opened, and the cycle repeated.

Proper scavenging of the power cylinder is performed in the Illmer gas engine made by the Reading Iron Co. of Reading, Pa., by conveying conduits which turn the working fluids and impart to them a direction of flow parallel to the cylinder axis, thus producing final longitudinal movement before discharging through the inlet port.

This port is commanded by an annual poppet valve placed symmetrically about the cylinder axis, and mounted to slide in a suitable housing. The inlet valve, when open, acts essentially as a baffle placed across the line of flow of the incoming charge, which construction, together with the central location of the valve, causes the working charge to spread into a hollow cone-like formation as it enters the power cylinder.

Co-acting with the inlet baffle, is a surrounding offset which reduces the high initial velocity acquired by the incoming charge when passing through the inlet port, and causes the charge to spread evenly over the entire cylinder area, so that the cylinder may be filled with explosive mixture to the maximum of its volumetric capacity, and by elimination of hot pockets of exhaust gases, avoids the troubles of pre-ignition and back-firing. Furthermore, the approach to perfect scavenging favors rapid explosion, as is clearly disclosed by the accompanying power cylinder indicator cards.

Notwithstanding the sudden and frequent variations of load, all the auxiliaries of the plant, such as the electrically driven tar extractor, water circulating pump, and ignition generator, take their current from the main generator, yet the certainty of ignition in this engine is such that reliable operation is secured at all times.

Pump Work

INLET valves of the type described admit of large opening into the power cylinder of 25 per cent of the piston area, and a pressure of 1 to 2 lb. per square inch is sufficient to drive the working charge into the power cylinder. Accordingly, the pump work can be kept at less than 5 per cent of the rated indicated power of the engine, as is shown by the pump card taken at 700 ft. a minute piston speed of the engine.

The device for charging the power cylinder of the Illmer gas engine, consists of a double-acting pump provided with a system of independent head end and crank end conduits of similar construction as seen in Fig. 4. Each such conduit comprises an air duct and a gas duct, which communicate with the pump and discharge to common mixing ports located adjacent to the inlet port of the power cylinder.

A suction valve is arranged to admit gas into the gas duct and, by means of suitable control devices, the pump is made to suck a stratum of gas into the gas

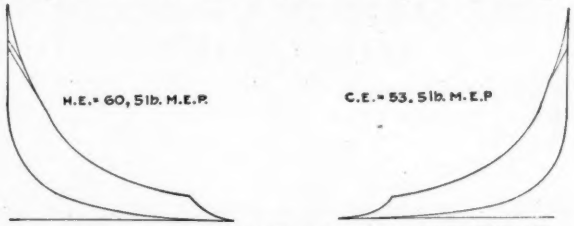


FIG. 2. POWER CYLINDER CARDS FROM THE ILLMER ENGINE

duct, where it is held in a body. This gas is not mixed with air until it is blown out of the duct and reaches the mixing ports. The suction valve simultaneously admits air alone into the pump chamber.

FIG. 3. CHARGING PUMP INDICATOR CARD

During the entire period of inlet closure, a body of scavenging air is maintained back of the inlet valve which, when opened, discharges this scavenging air into the power cylinder. The body of gas is then blown out of the gas duct and, just prior to reaching the inlet port, meets and is mixed with a portion of the air simultaneously discharging from the air duct. The explosive mixture thus formed passes into the power cylinder as a working charge. Identical operations are brought about in the other end of the pump.

A simple pump bypass provides for altering the ratio of gas to air. The relation of the explosion pressure in one end of the power cylinder to that of the other end may be readily varied while running. Suitable devices have also been developed for facilitating the desired stratification of the gas in its duct, and the effectiveness of the controls employed is apparent from the reproduced power cylinder cards.

In the 2-stroke engine, the piston performs the function of exhaust valve, having exhaust port opening unrestricted, and any carbon crust or other loose deposit is blown out of the cylinder. Even when using gas containing considerable amounts of tar, dust or other impurities, the piston controlled exhaust port is capable of reliable operation.

Inlet Valve Gear

POPPET inlet valves are positively actuated both in opening and closing by means of an eccentric drive, through a double toggle linkage as is clearly illustrated in the elevation view of the engine, Fig. 1.

This gear imparts properly accelerated and retarded movements to the valve, and causes it to seat gently; the toggle linkage then presses the valve upon its seat. This mechanism operates without the use of cams or closing springs of any kind, and is effective in rapidly actuating large valves with ease and certainty of movement.

Complete provision for independent adjustment is provided by making all link pins bronze bushed and the links provided throughout with keepers to afford compensation for wear.

Power Cylinder Construction

THE double-acting power cylinder of the Illmer gas engine is fitted with separately inserted and replaceable liner sections, which are in direct contact with the cooling water. Provision is made for the free expansion of the liners, and the exhaust ports, drilled into the inner liner ends, are also adequately water cooled.

These ports are surrounded by an annular exhaust chamber cast integral with the cylinder body, which chamber discharges directly into a single exhaust pipe fastened to the base of the cylinder body. A handhole opening into the exhaust chamber admits of cleaning the exhaust ports, if necessary, and provides means of inspecting the piston rings for wear and breakage without necessitating the removal of the piston from its bore.

Inasmuch as the explosion proper takes place in the separately attached cylinder heads, the cylinde bore is protected, to a large extent, from the rapidly repeated high temperature and pressure stresses, and the easily replaceable cylinder heads are especially designed to withstand such strains without destructive fatigue effects.

Each such head is suitably water cooled and provision is made for relieving expansive stresses. The perfectly symmetrical shape of the head about the

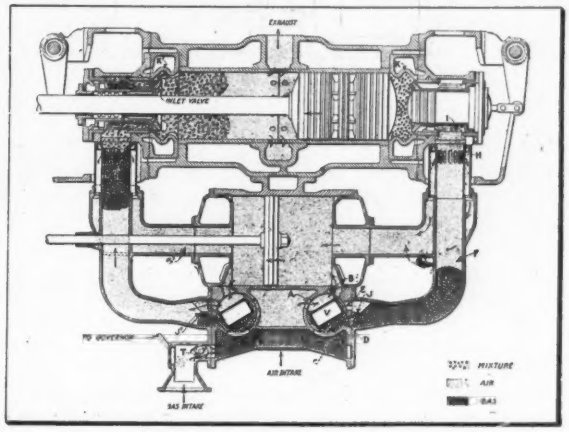


FIG. 4. SECTION THROUGH CYLINDER AND PUMP OF ILLMER ENGINE

cylinder axis forms an ideal combustion chamber, and the central opening in its outer end constitutes the inlet port. Owing to the small surface exposed to the explosive temperature, the amount of jacket cooling water required for an engine of this type is relatively small.

The water cooled piston is cast in half sections which are bolted together as shown in the detail illustrated. The heads are as nearly spherical in shape as possible, with metal uniformly distributed to avoid localized heating. The elimination of all ribs allows the head to conform, without cracking, to any warping action resulting from unequal temperature strains. One of the piston heads is fastened to the piston rod by an internal nut, while the piston body is free to expand in its axial direction.

The cooling water is circulated through the hollow piston rod and, on account of the 2-part construction, deposit of any kind is readily cleaned from the interior of the piston. The guiding action of the comparatively long piston used stiffens the piston rod and allows the use of relatively small rod diameters.

Double snap rings are provided for each of the 6 packing grooves in the piston, giving 12 rings to resist leakage and offer an ample factor of safety against ring breakage.

Lubrication of the power piston is facilitated by its considerable length. Two top and 2 bottom lubricator plugs are provided at each cylinder end, 8 lubricator plugs in all, for each power cylinder. By thus applying the cylinder oil directly where needed, the oil consumption and wear are reduced to a minimum. The need of but one set of metallic piston rod packing rings, results in a saving not only of considerable cylinder oil, but also in the expense of piston rod replacement.

A force feed pump accurately times the injection of cylinder oil and the piston is of sufficient length to admit of a practically continuous feed of oil to the

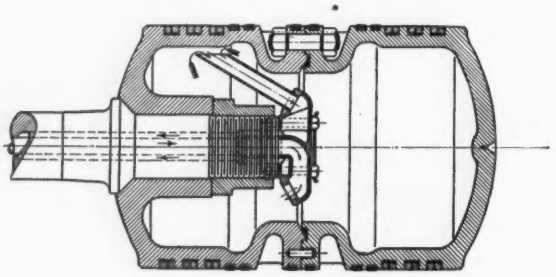


FIG. 5. DETAIL OF POWER PISTON

rubbing surfaces. By the use of a suitable lubricant and of close grained liner metal, the bore takes on a perfectly smooth and bright finish, and the wear, under proper operating conditions, does not exceed 0.01 in. a year.

Cylinder heads and valve parts are all concentrically fitted and held in perfect alinement with the cylinder bore; in fact, the entire engine is designed for concentric construction, the cylinder also being centered in the frame housing and not dependent upon the foundation for alinement.

A further important feature of construction is the comparative ease and facility with which the cylinder head and the valve parts may be dismantled for repairs or inspection of the interior of the power cylinder, which may be done without disturbing the alinement of the engine, or the adjustment of the valve gear. The pump parts are also easily accessible; in fact, all working parts are above the floor level and readily served from an overhead crane.

The frame of the engine is of the rigid box girder type, having a bored crosshead guide, and rests throughout the entire length on its foundation, which extends back in full section to the end of the power cylinder tail piece.

The crank mechanism is of the side crank type, driving the pump by means of a drag link, so that the crank shaft is supported only in the main and outboard bearings and is free to compensate for wear without disturbing its alinement.

The ignition gear is of the positive make-and-break low-tension type, designed to maintain accurate synchronism in the ignition timing with suitable system of planetary gears, encased in a single detachable box, to change the timing of all 4 igniter plugs simultaneously.

All important parts of the engine, except the power cylinder, are lubricated by a flush oiling system, the oil being drained to a central filter before being returned to the bearings.

PRESSURES IN A REFRIGERATING SYSTEM

TO get the best results, the proper conditions of condenser pressure and back pressure in a refrigerating system must be maintained at those values which experience and practice show to be right for the desired temperature of refrigeration and available temperature of the cooling water. If the square feet of cooling surface in the condenser per ton and the pipe capacity are properly designed and the system is practically free of noncondensible gases, the values of condenser pressure for different amounts of cooling water per ton of refrigeration in 24 hr. and for different temperatures of cooling water can be taken from the curves as given in the Data Sheets.

Also for given temperatures in the refrigerator the back pressures on the system and the temperatures corresponding are to be maintained as shown in the Data Curves.

It is probable that in some cases slightly higher efficiency can be obtained by varying somewhat from these pressures and experiments should be tried in varying the pressures until the best possible running conditions are found, after which by means of pressure gages or even better by thermometers in the suction and discharge pipes of the compressor, the conditions should be kept at the point found to give the best economy.

During the spring and fall when the temperatures of the air and the cooling water are low, the range in pressure can be reduced below that necessary in the hot summer months and these pressures should therefore be adjusted at the beginning of the season in the spring, at the beginning of the heated term and again at the end of the heated term when the fall temperatures become prevalent. The values from which the curves were plotted were taken from Elementary Mechanical Refrigeration by F. E. Matthews, with the temperatures corresponding to the different pressures corrected according to the tables of Goodenough & Mosher.

STANDARD PIPE DIMENSIONS

OWING to the changes in dimensions of standard steam piping which have been adopted since publication in the Practical Reference Tables some 2 yr. ago, it is thought wise to bring these up to date, and put the tables in a little different form for the convenience of readers.

In this issue, therefore, will be found, in the Reference Tables, a number of these standard pipe dimensions. In subsequent issues more tables will be given, in order to make the data complete. In order that no confusion may be made, it would be well for those who have kept the former tables, to destroy them and substitute those found in the present and succeeding issues.

LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

INDICATOR TIMING

RECENTLY an engineer friend asked the writer to bring over an indicator and take a few cards for him. Happening to be in the vicinity the other day about 5 p.m., I just had time to catch him and arrange to set up that night in preparation for the following day. He left for home after showing where the tools were kept.

His engine was a Westinghouse standard vertical type and the usual method was followed; that is, a framework was placed to carry a small pulley over which runs a cord connected to the paper drum of the indicator at one end, the other end being connected by means of a hook to a pin placed in a wooden block fastened to the revolving shaft.

The accompanying sketch may be of service. Between the indicator and pulley was placed a rubber band to take up the motion when cards were not being taken. When a card was to be made, the hook was pulled up so as to engage with the small loop. This makeshift was thought necessary since no detent mechanism could be readily employed, but as the speed of the engine was only 280, it was found a simple matter to use a straight cord connection and catch the revolving pin P in wooden block B.

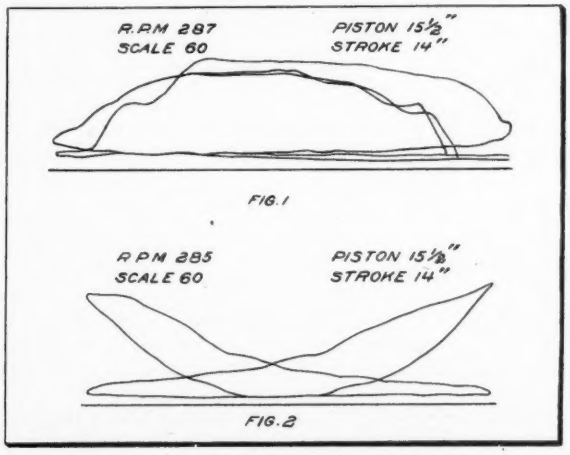


FIG. 1. CARDS WITH PIN DISPLACED
FIG. 2. CARDS WITH PIN PROPERLY ADJUSTED

The engineer stated that the wooden block B had been previously used in taking indicator cards some few years ago, and when the flywheel was turned over by hand, the length of the card was seen to be only about 2 in. As we desired about a 4-in. card, the pin P was offset from center some 2 in., and on again turning over the flywheel, a satisfactory length of card was obtained. This changing was done after the engine room was quite dark and light was obtained by a pocket flash-light.

Next morning a few cards were taken and showed the results in Fig. 1. The engineer was quite disappointed and looked the part.

After a little it occurred to us that possibly the pin had been set in the wrong position. At noon-hour the position of the pin was noted, and the front plate of the

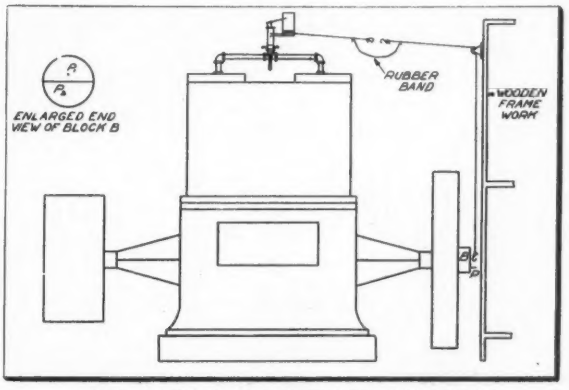


FIG. 3. DIAGRAM OF INDICATOR CONNECTION

engine removed. It was at once seen that position of pin P_1 was removed just 90 deg. from the correct position of pin, shown by P_2 in enlarged view of the block B. The pin was placed in the proper position and after starting up the resulting cards were as shown in Fig. 2. The engineer was better pleased and we all learned a little lesson in the value of using care in the little matters.

C. K. N.

TROUBLES WITH A SECONDHAND DYNAMO

THIS subject brings to mind the experiences of a company by whom the writer was employed as engineer. It was decided to install a motor-generator set in the plant and a 180-kw., a.c., 2200-volt, 60-cycle, 514-r.p.m. and a 200-kw., d.c., 600-volt, 500-r.p.m. machines were purchased secondhand and with the pulleys removed, set with shafts end to end and connected by a flexible coupling made up the set. The a.c. generator originally was an 1100-volt machine but had been rewound for 2200 volts. The d.c. generator must have been operated without shunt connections on the brushes as there was not a shunt on the machine, many of the springs were partly melted away, and many of the brush holders were partly melted away and drops of brass hung from some of the under brush holders like icicles.

New shunts, springs and brush holders were placed where needed and placed in operation; in a short time the armature burned out, was patched, and in a short time again burned out, then the armature was rewound and in about a year it burned out again, and it never carried normal load, but was replaced with a new and larger set.

The next experience, a 150 or 200-hp., 2200-volt, 2-phase, 60-cycle, induction motor was wanted to drive a power pump in a water works plant. A secondhand firm had one for sale and said they would rewind it; the machine was purchased, installed and started. From the beginning, this motor took an excessive starting current, and created a heavy inductive influence on the system; we could not start it with 2 180-kw. generators operating in parallel a mile and a half distant.

In the course of a few months some new parts were wanted and the makers were communicated with, giving the number of the machine; then it was found that the machine was originally a 440-volt, 25-cycle motor and the secondhand dealer rewound it for 2200-volt, 60-cycle on the old laminations; it was rated at 200 hp. but did not develop much over 125 and ran very hot at all times. Later, the stator burned out and to have it relaminated and rewound would cost about as much as a new machine. A 150-hp. motor was recently installed and is not noticed at the power plant when going on or off except by the integrating wattmeter reading. A saving of from 400 to 700 kw. hr. in power per 24 hr. is also noted by the meter readings taken daily. C. E. Nye.

A FELLOW ENGINEER'S ADVICE

ENGINEERS, do you know there is a growing cause for alarm and that if we do not soon wake up we will soon fully realize it? The college man, like central station service, is here and to stay. Some, I will admit, when they first come out feel their importance. A few never get over it, but more go right into actual work, in the engine manufactory, engine room, or on the road, and get the practical part of it. Then they are prepared for us, and my friends watch out for the recoil. When they come back at us later it is liable to stun some of us.

Some of us have had an idea that there was but one way to gain the distinguished calling of stopper and starter, or to fire to see how much coal we could throw on a shift and then brag of it, simply to keep her hot, no particular matter of how done, or the cost of so doing, and as is often said, "He is a good fireman, always has her hot." Then later when we are promoted or move to another job as "Engineer" we may wake up to find there is another route, the school followed with a practical training, and this latter class of men will step in ahead of us and can and will produce results that we cannot or had not thought of. Yes, they are an ambitious lot and we must watch out or we will be turned out.

The time is now passing when we can run our present, or any plant, on the guessing system. Our employers, too, are being educated. They will call in consulting engineers, very likely without referring to us. They too are alert. We must prepare for them too. They will not long allow us to continue in the old slipshod way. They have a right to, and do, expect more and better work of us and our plant. If we cannot produce or suggest practical ways of improvement, savings, etc., college or the central station fellows will certainly step in and we will have to advertise in the "Want" columns—"Position wanted by a first class engineer, middle-aged, man with family, 25 yr. on last job. Can do my own firing; understand Corliss and other engines, boilers, pumps, etc. Left my last position because central station service was taken on. Best of references. Address—Starter Hasbeen, N. G."

The present times and apparatus demand of us careful study and advancement. It is a time of hustle and sharp competition in all trades both manufacturing and labor. If we expect to continue we must soon get down to business.

How many of us old timers who have handled slide valves, perhaps a Corliss or an automatic, could step into an up-to-date turbine or producer gas plant, and hold it down? Now don't kick, stop and spend the time in study. If it is too late, as it is with many of us, to attend school, take a course in a good correspondence school, of which there are several, and spend the necessary time in study. Get good books, take good papers, then make use of them. Study at home and a whole lot can be done at the plant. But few employers will object when they understand the advantages to each. At any rate, study.

Then you will be better prepared for competition with the college man. Some of them you need not fear: the fellow who insists on wearing the boiled shirt, stand-up collar, cuffs down over his hands, pants turned up 1 or 2 turns, he will tell you very quickly all he knows, he is innocent; his bite is harmless. But the other fellow who comes around, "the plain clothes man," sizes up, makes some notes for future use, does some thinking and no talking. Watch out for him. This class of man, even if he does not throw the coal himself, may and probably can show the boss where savings can be made and expenses cut. They will not do as some men I have seen, who were in their time considered good, set valves by measurement (or the wedge system), feed boilers with injectors because the pumps made them so much trouble, use a wad of rags on a stick for a flue cleaner, use hand dampers or none at all, use tar, rosin or soap as a belt dressing, have no records, no books, no papers. Honestly how long do you think this system can last with the other fellows showing us up, or ready to do so?

Personally I have been up against some of these college men; some like a boil make me very sore, but they are soon gone and I am the better for it. Others who have been taught in the college that a certain coal has so many B.t.u.'s; that in order to get combustion it requires so many cubic feet of air; that there should be such a percentage of ash in the coal; that so many pounds of steam is a horsepower, and many other useful facts, find when they take up the firing scoop it requires something they did not get in the college. To produce that there is a certain amount of "know how" about it. When this fellow puts the overalls on, fires, cleans flues and boilers and gets into all kinds of everyday plant jobs, thinks and figures, he will produce. This class of fellows has me on the run and there is a lot of this class of men coming our way.

It is best, it is absolutely necessary for us to prepare for this severest of competition. There is yet time for us, but it means business pretty soon. We are not like locomotive engineers who after having served a certain length of time will be released on a pension. We will get the first, but the last will be forgotten. We positively must improve our own efficiency or like some of the good old "has been" engines, no matter how much we have done, shall be scrapped. Hyde.

NOISY TELEPHONE CURED

SOME months ago I wrote about a noisy telephone line on the same circuit with 2 3-phase, 60-cycle transmission lines, and was given some information as to how to correct it. Also something was published about it.

The trouble was finally located and corrected. It is so unusual that I am passing it on to readers of Practical Engineer.

At the power house the telephone passed through the wall. First there was an iron tube cemented into the wall. Inside of the iron tube was a porcelain tube that was loose and inside of the porcelain tube was the wire which was also loose. I have talked over the line from my office almost 50 miles away, and the "singing" was quite distinct and annoying.

The porcelain tube inside of the iron tube was made firm, and the wire inside the tube was drawn tight. The noise stopped at once. Once since then the porcelain tube became loose and the wire slack and the noise began. Tightening the wire and making the tube so it could not move with the shaking of the brick walls, cleared the noise off the line.

W. H. K.

COOLING DRINKING WATER

THE computations, as submitted by A. L. R. in Practical Engineer of Aug. 15, in answer to A. E. C.'s query as to the installation of a water cooling system, are too clearly stated to have sprung from the pen of a pure theorist. Yet, the solution by A. L. R. covers only the theoretical demands of the system under discussion. The most important factor in the operation of water cooling equipment—I refer to the inefficiency, inseparable from the practical operation of such equipment—has been apparently overlooked by him in his reply to A. E. C.

Reviewing the proposition by the latter to install a water cooling plant, I note that the building in which the apparatus is to be provided, is an 8-story building, having an occupancy of approximately 700 persons. A. L. R. assumes as a basis for his computations that each person will consume approximately one quart of water per 24 hr. Proceeding, he finds that approximately 200 lb. of ice is required during that period to cool 1500 lb. of water through 20 deg. His figures, as far as they go, are excellent, and the method in which they are stated, could not be improved upon. It is, therefore, unfortunate that he should have failed to draw attention to what is undoubtedly the most important factor to be considered in determining the capacity of the installation to be provided in the building under consideration.

In a water cooling system for such a building, the amount of water consumed for drinking purposes by the tenants is a relatively unimportant factor in deciding on the size of refrigerating plant. To ensure, at every point of the piping system, a ready supply of drinking water at a proper temperature, it is necessary that the water should be constantly circulated through the piping. We must therefore consider the refrigerating losses through the covering of piping and fittings. These are sometimes of considerable extent. It is also impossible successfully to utilize 166 B.t.u. per lb. of melted ice, when used for cooling water that is flowing through a piping system, and a liberal allowance should therefore be made for the inefficiency of this arrangement. Also, the frictional heat, arising from the constant circulation of the drinking water, should not be neglected as another factor in the determination of the cooling capacity.

In view of these considerations, it is evident that A. E. C. could not operate the proposed system in his building on 200 lb. of ice per day. Further, it would be impossible for him successfully to operate the system on less than 1 to 2 tons of ice per day. The wide difference between this amount and the theoretical figure is easily accounted for in the losses above described. In support of this statement, I append herewith a tabulated record, showing the result of an 8 hours' test of a water cooling system, installed in a building somewhat similar in its nature and proportions to that described by A. E. C. This test was repeated on 2 other occasions, and the results in each case showed that the figures given in the following record represent normal operating conditions.

Time	Temperature at Cooler Deg. F			Water Circulated per hour in pounds	Make-up Water		Refrigeration tons per day at Cooler
	Inlet	Outlet	Difference		Cubic ft.	Lbs.	
a. m.							
9–10	50	46.0	4.0	12,198	8.5	531	4.58
10–11	49	44.5	4.5	11,834	7.7	481	4.95
11–12	48	44.0	4.0	12,151	9.8	612	4.73
12–1	48	44.0	4.0	12,041	8.5	531	4.61
p. m.							
1–2	48	43.5	4.5	11,903	10.0	625	5.16
2–3	47	43.0	4.0	12,073	11.3	706	4.85
3–4	47	43.0	4.0	12,014	10.2	637	4.76
4–5	48	44.0	4.0	11,752	8.0	500	4.49
Total				95,966	74.0	4,623	
Average				11,996	9.25	578	4.76

Type of Refrigerating Plant, CO_2. Height of Building, 10 stories. Size of Circulating Pump Triplex 6″ x 3″. No. of Occupants 800-900 approx. Separate system for water drinking circulation. Piping all covered with standard thickness of cork covering. Average temp. of makeup water, 60 deg. F.

From these figures it is evident that the amount of "make-up" water, representing the consumption of drinking water by the occupants of the buildings, has but a slight bearing upon the refrigerating work performed by the machine. The most striking confirmation of this truth is obtained by a comparison of the refrigeration tonnage of the machine during the hour 9-10 a.m., when the use of drinking water amounted to 531 lb., and the tonnage of the machine during the hour 2-3, when the use of drinking water amounted to 706 lb. During both of these hours, the amount of water circulated by the pump was practically the same.

In water cooling systems, as in other mechanical equipment, we are often inclined to magnify the practical working efficiency of the apparatus, and I feel, in submitting these figures, that they will be of value as a guiding factor, not only in the proposition of A. E. C., but also to a certain extent in the installation of similar apparatus in other buildings, differing widely in character and proportions from the one under discussion.

J. A. McHollan.

IN A NEWSPAPER REPORT of the burning of the power plant at Medford, Okla., it is stated that the fire originated in a pile of slack coal which had been burning over 2 weeks in the southeast corner of the building. This is possibly a reporter's error, but if it is true it shows a lamentable lack of appreciation of the danger of a burning coal supply. The plant, which consisted of a 75-hp. Corliss engine, and one of 35 hp. with boilers and electrical equipment to correspond, was a total loss, but will be rebuilt at once.

EFFECTS OF SHIFTING ECCENTRIC OF SLIDE VALVE ENGINE

THIS chart is drawn to illustrate my experiment with a 9 by 12-in. slide valve blower engine which was used to run a 10-ft. diameter fan, blowing hot air blast for heating the mill. Figure 2 is a cut of the valve and dimensions. My idea is to show what conditions of

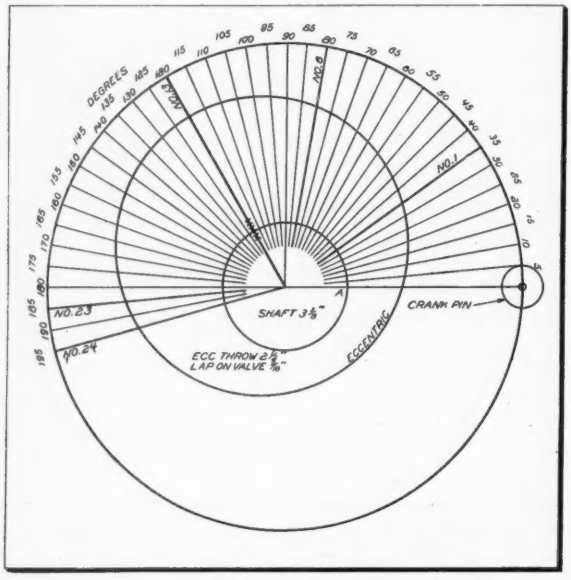


FIG. 1. CHART SHOWING ECCENTRIC POSITION

steam distribution prevail when the eccentric is placed at different angles, represented by degrees, ahead of the crank and to give for each degree position an indicator card actually taken when the eccentric was placed at these angles. My method of procedure was first to graduate the 3⅜-in. engine shaft into 360 deg., making my zero at A in line with the crankpin, and next to find the center of the eccentric and draw a scratch mark through it at X. I now have the engine shaft scratch marked in degrees all around, and center line through the eccentric X. The eccentric can now be placed at any of these, cards taken and the degree of setting marked on every card, together with the deformities peculiar to its respective position.

Card No. 13 was taken when the valve was set, as I call properly, for a slide valve. From this position I advanced by degrees, taking a card for each number until the valve setting was so distorted that at 195 deg. ahead of the crank, which was the eccentric position, the engine refused to go forward but would go backward quite rapidly (see card No. 24), yet card No. 23 would go in the former direction if throttle was wide open, but

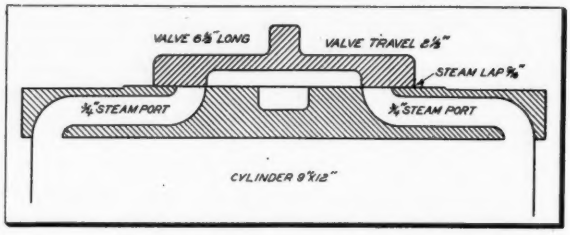


FIG. 2. SLIDE VALVE SHOWING DIMENSIONS

slowly, barely pass the centers; then I put the eccentric back of 120 deg., as shown by cards Nos. 1 to 13, until, as in card No. 1, the engine would barely have start enough to carry it over the centers with throttle wide open, so great was the reverse resistance.

It will be remembered that this engine had a 10-ft. diameter fan and the wind resistance was no small item, as I have other cards taken when the engine was running ordinarily, which at 132 r.p.m. gave a mean effective pressure of 28 lb. I hope this will help those who are not familiar with what takes place when the eccentric is put forward or back of its proper position.

A. C. Waldron.

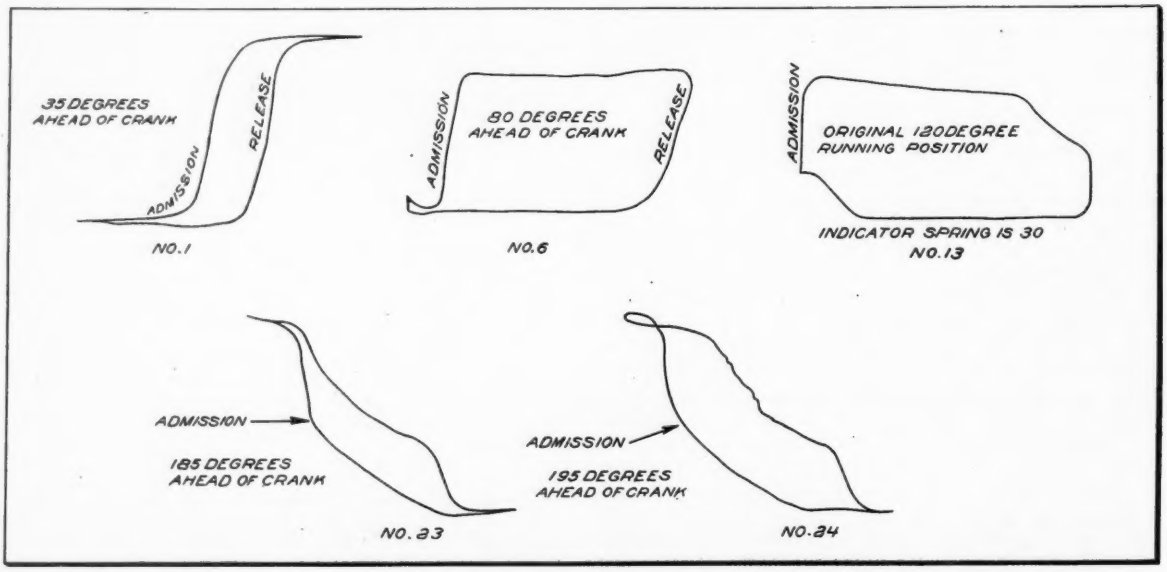


FIG. 3. CARDS TAKEN FROM SLIDE VALVE ENGINE WITH VARYING ECCENTRIC POSITIONS. No. 1, 35 DEG. ADVANCE; No. 6, 80 DEG.; No. 13, NORMAL 120 DEG.; No. 23, 185 DEG.; No. 24, 195 DEG. ENGINE REVERSED

OPERATING ENGINE WITH DIRECT-DRIVEN JET CONDENSER

WE see in the technical papers, from time to time, articles on starting and stopping compound engines, and how an engine was wrecked from water getting into the low-pressure cylinder by not shutting the condenser valve. This is, of course, neglect, and forgetfulness on the part of some engineer who does not thoroughly understand this system of operation or actually forgets at the critical moment.

I have had many years' experience with compound condensing engines, using different types of condensing apparatus, and will describe the method of starting and stopping; first with a compound engine using a jet type of dependent condenser with bucket pump connected to low-pressure crank.

This system of operation is as simple as one could wish, if we remember the manner in which a vacuum is formed and follow a routine of procedure when starting. This type of bucket pump jet condenser is generally located beneath the guide on the low-pressure side of the engine. In starting, the inlet water supply valve to the condenser is closed, also the forced injection valve, and the outboard valve if there is one. It does not matter from which side (high or low-pressure) of the engine we start.

First admit steam to the cylinders and receiver and warm it up in the usual manner. If there is no out port valve, the steam passed through the cylinders and receiver to warm up the engine must all pass through the condenser chamber. As it accumulates pressure in the condenser chamber, it will force open the suction valve below the bucket and the valves in the bucket and escape through the delivery valve to atmosphere. This will heat the condenser just what is necessary.

Now, if the engine is thoroughly warm, oil all started and everything ready to start, shut the throttle to prevent more steam passing through the engine and hook up the steam valve on whichever side you desire to start from. In this case we are starting from the high-pressure side. As quickly as possible open the forced injection valve admitting water to the condenser chamber enough to condense the steam contained therein, then shut the forced injection valve to prevent the destruction of the 4 or 5 in. of vacuum thus created in the condenser. Now open the throttle and admit steam enough to start the engine and turn it over 1 or 2 revolutions, closing the throttle valve when this amount of steam has been admitted, open the forced injection valve to condense this steam as it is exhausted from the low-pressure cylinder into the condenser and as the bucket pump is now moving with the engine, the vacuum will be built up.

When there is sufficient vacuum in the condenser for the water to be forced into it, by atmospheric pressure, open the inlet water supply valve and close the forced injection valve and the engine is now ready to be speeded up and the load put on. Do not open the inlet valve wide on starting up. Open it only enough to admit sufficient water to condense the steam which is passing through the engine. The pump is running slowly and will not take care of the large volume of water that it will when it is speeded up. It must be remembered with this type of condenser, when the throttle valve is closed little condensing water is required, hence it is always safe to close the inlet valve partly whenever it is necessary to stop or slow down the engine.

In stopping an engine of this type, it is only necessary to close the throttle valve, then the inlet water supply valve, shutting the water off from the condenser. Any steam which may leak past the throttle valve will force its way up through the valves in the condenser and bucket, escaping through the delivery valves to the atmosphere. The delivery and suction, also the bucket valves, must be of a quality to stand considerable temperature, as the entire exhaust from the engine generally has to pass through the pump, if the vacuum is lost.

This is one type of jet condenser which has generally been installed without a stop valve between the engine and condenser, and generally without relief valve. We always wonder how such an installation is run successfully for many years and never a mishap. This is why: The condenser is placed in the basement beneath the guide of the cylinder, so the inlet water and discharge pipes, as well as the exhaust from the engine are all below the cylinder.

In many instances the water from the condenser chamber will flow from the pump by gravity, as the pump is usually placed beside the condenser chamber and a few inches below it. When the condenser chamber is full of water it would, if there was no vacuum in the engine cylinder, flow through the pump to the atmosphere, as soon as it had reached a height in the condenser chamber to destroy the vacuum.

A vacuum breaker on the side of the condensing chamber would admit air to the condenser and destroy the vacuum, allowing the water to flow from the chamber and also prevent more water from flowing into it.

With this type of condenser installed, there is no real necessity for a stop valve between the engine and condenser, no actual need for a valve. The exhaust pressure in the condenser chamber would have 2 outlets; first through the pump, second through the suction pipe of the condenser, and could not get any water into the cylinder unless a vacuum were created therein, and also in the receiver which is generally the case, while the engine is running slowly and the vacuum breaker is either stuck or the draught of water from the condenser is so great and quick that there is not sufficient time in which it could operate to relieve the cylinder and save the engine. Therefore, it is always best to shut the inlet or suction valve on the dependent bucket pump condenser after closing the throttle.

R. A. Cultra.

WHILE THERE IS A difference of opinion among mechanics and belt makers as to whether the lap joint of a belt should run with the leading point next the pulley or on the outside, the method recommended by the Chicago Belting Co. for single-ply belts, is that the leading end shall be on the pulley side. This prevents the joint from opening; when the leading end is on the outside it tends to open up slightly, especially if the belt is running at high speed, because of the air resistance; as soon as a slight opening occurs the atmospheric resistance tends to increase it, but if the leading end of the lap is next to the pulley the tendency of the point to rise is overcome by frequent pressure against the pulley.

For a double or 2-ply belt, the inner ply should be laid with the leading point on the outside and the outer ply with the leading point on the inside; that is, both the leading points should come in the center of the belt, where they will be protected, as the outer ends of both plies will be to the rear and not subject to atmospheric pressure. The substance of this discussion is taken from a brief note in Machinery.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Card Criticisms

ENCLOSED card was taken from a Hamilton Corliss engine, 16 by 42 in., which has been rebored 3 times. It runs at 96 r.p.m.; boiler pressure is 100 lb. Please tell me what changes can be made to improve this card. M. W.

A. In the diagram there is too much lead, which is shown by the sharp rise in the admission line where it joins the compression line, and by the quick drop of the pencil as the piston starts off on the return stroke. The excessive compression would have carried the pressure in the clearance space to the steam chest pressure without the lead which admitted some steam before the compression was complete, and which was forced back through the narrow lead opening into the

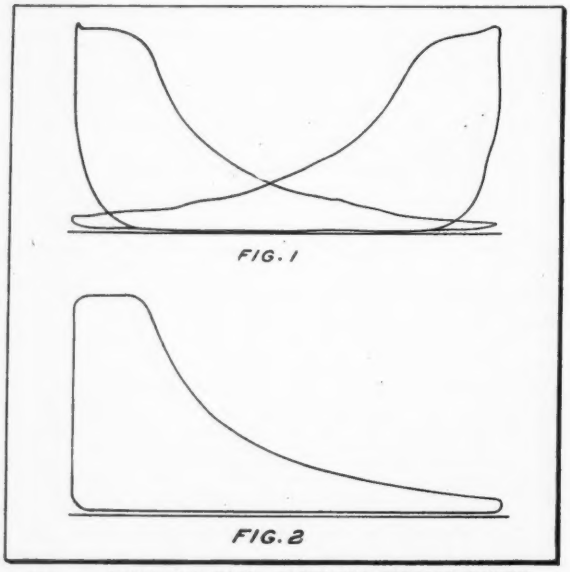


FIG. 1. DIAGRAMS FROM HAMILTON CORLISS ENGINE
FIG. 2. IDEAL CORLISS ENGINE DIAGRAM

steam chest, causing the rise of the pencil, which shows that the pressure in the clearance space for an instant was above that in the steam chest.

The exhaust valves have too much lap; this is shown by their early closing and altogether too late opening.

The valves should be reset as follows: With the wristplate at the middle of its travel, adjust the valve connections until the steam valves have 5/16 in. lap and the exhaust valves are both open 1/32 in. Then, with the crank on the center, hook the reach rod to the wristplate and turn the eccentric until the steam valve has a lead of 1/64 in.

This valve setting should give an indicator diagram similar to the sketch, which represents the best possible steam distribution in a Corliss engine cylinder. F. L. Johnson.

Loose Engine Boxings

WHAT effect does it have to run a 400-hp. engine, (slow speed), with boxing too loose?

Is it practical to drive keys while an engine is running? W. R. Smith.

A. The general effect of running an engine with loose boxes, is a rapid wear at all such parts. The effect is much the same as if the boxes were placed under a steam hammer and a light blow struck at every reversal of motion. The crank and crosshead pins will suffer most.

If the main bearings are of the 4-piece type, the lower shell will slide back and forth on the base bearing, leaving a ridge at each extreme, and eventually this will become so bad that later attempts to draw the bearings up as snug as they should be, are attended with disastrous results. This is especially true if the wedges on either bearings or pins are permitted to operate loose long enough so that a shoulder is formed; for as soon as the bearing is tightened even a small amount, this shoulder is drawn in and the bearing is too tight, besides creating a new bearing between the box and the wedge, the surfaces of which are no longer in the same plane.

It is one of the laws of nature that neglect breeds decay and disaster. Loose bearings promote strains in the engine and foundation which if aggravated by continued operation, will result in accident.

The writer recalls 2 slow-speed engines which were permitted to operate with bearings very loose. On one the engine eventually worked endways about 3/16 in. at every revolution. The other eventually broke the frame. The last engine had an 18-in. shaft in the bearing, which was worn flat on one side ⅛ in. and the crankpin almost an equal amount.

Another effect of operating an engine with loose bearings is to batter the babbit if of a ductile nature; or if it is very hard, it will crack in small pieces which are liable to cause heating if some of the small particles work into the bearing. The writer has found upon removing the 6-in. shaft of a high-speed engine (260 r.p.m.), which was direct connected to a 100-kw. generator, that the bearings were broken into pieces mostly diamond shape, and averaging about an inch on each side.

As soon as the shaft was raised out of the bearings, the babbit fell in, in a pile.

We take it that you mean keys such as are used in the ordinary strap end rods with gib and key adjustment. It is not practical to adjust such bearings while in operation, for obvious reasons. Usually there is a set screw or some such device which requires to be loosened and tightened when making adjustments, and this is hardly possible with even the modern slow speed engines. Then also, one cannot "feel" the play unless the adjusting is done when at rest.

Still, it has been done, and can be done again under certain conditions. G. H. Wallace.

Demagnetizing a Watch

WILL you kindly explain how to demagnetize any piece of iron that has become magnetized? I have a watch whose spring has become magnetized.

W. L. C.

A. Two methods are in use for demagnetizing a watch which is magnetized. The first is used as a temporary expedient, and if carefully handled, will do reasonably good work, but will not usually remove all the magnetism.

This consists in putting the watch into some kind of a holder suspended by strings at the 4 corners, so that the watch will lie horizontal. Then bring the watch near to a strong electro-magnet, first twisting the 4 suspending strings together so that if released, the piece holding the watch will spin around. Have the strings twisted rather tightly. Then, with the watch near the magnet, release the receptacle so that it will begin to spin and move the watch straight away from the magnet while it is still spinning. This tends to reverse repeatedly the direction of magnetism through the steel part of the watch, and in this way neutralize the magnetic effect.

If this is not successful on the first trial, which can be told by use of a small compass placed directly over the balance wheel, it can be repeated, bringing the watch not quite so near the magnet as before, and again removing it while it is spinning. A little compass, about half an inch in diameter, placed over the balance wheel of a watch will swing back and forth with the wheel if the watch is magnetized, and will stand still if not magnetized.

The second method for demagnetizing a watch is to have a coil inside which the watch may be placed, and through the winding of which alterating current is passed. This accomplishes the same effect as before, by reversing the magnetic field through the watch, and thus killing any residual magnetism. The current should be shut off gradually from the alternating current coil by throwing in resistance, so as not to get a final inductive "kick" in the coil, which might leave some permanent magnetism in the watch.

This second method is the better, but, of course, involves special apparatus.

New York Examination Questions and Answers

WHERE should the feed water connection be placed on a boiler and why?

A. In the Massachusetts Boiler Rules, the requirements are that "for a horizontal return-tubular boiler the feed water shall discharge about 3/5 the length of the boiler from the front head, except where an auxiliary feed-water heating and circulating device is used, and about the central rows of tubes and above the tubes when the diameter of the boiler exceeds 36 in. and the pressure carried exceeds 25 lb." The feed pipe is to be carried through the head or shell with a brass or steel boiler bushing or the opening is to be reinforced, and the feed pipe must be securely fastened inside the shell above the tubes. The feed water must not discharge in close proximity to riveted joints in the shell or furnace sheet. For other types of boilers the discharge of the feed water should be in a corresponding position. The reason for this arrangement is so that the feed water may become heated before it is discharged from the pipes so that it will not strike against the hot plates of the boiler and cause contraction which would tend to strain the material or open the joints.

2. How would you determine the size and number of stay bolts to be used in a boiler?

A. The same authority gives the following. The minimum thickness of plates in stayed, flat surface construction shall be 5/16 in. To find the maximum pitch of stay bolts not exceeding 8½ in.: Add 1 to the thickness of the plate in 16ths of an inch; square this sum; multiply it by 66 and divide by the working pressure in pounds per square inch. Add 6 to the quotient and extract the square root of this sum; the answer will be the maximum pitch of stay bolts in inches, and the number of bolts can be determined by deciding how many bolts are required with this pitch as computed to stay the surface in question. To decide on the size of stay bolt required, the following data are given: For bolts up to and including 1¼ in. diameter, the maximum allowable stress per square inch of net cross-sectional area at the bottom of the thread is 6500 lb.; for sizes over 1¼ in., 7000 lb. The diameter of a bolt at the bottom of a thread is equal to, the external diameter minus (pitch of thread times 1.732).

3. How many cubic feet of steam at atmospheric pressure weigh 1 lb.?

A. This is found from the tables of properties of saturated steam and for 14.7 lb. per sq. in. absolute is given as 26.4 cu. ft.

4. How is a hard patch put on a boiler and when, due to its position, can it not be riveted?

A. A hard patch is always riveted to the boiler and the edges then calked down to make a tight joint. The patch is first shaped to conform to the surface which it is to cover, the injured part is then cut out and the patch and boiler are drilled together for rivets. The patch is then put on, riveted in place and the edges calked both outside and inside. A hard patch should always be riveted and where the break makes this impossible, sufficient of the plate should be removed so that riveting surface can be obtained.

5. How far apart should ¾-in. rivets be placed on a boiler?

A. This depends on the thickness of the plate used and the arrangement of the riveting, but the pitch cannot be made greater than a certain maximum or the joints cannot be calked and remain tight. A rule given by the National Boiler Insurance Co. is that the diameter of the rivets shall be about twice the thickness of the plate, which would make a ¾-in. rivet suitable for ⅜-in. plate. A rule worked out from practice which gives good results is as follows: Square the diameter of the rivet and multiply by 3.1416; divide by the thickness of the plate and multiply the quotient by a constant which for single riveting is ¼, for double riveting ½ and for triple riveting ¾; to the result thus obtained add the diameter of the rivet and the sum will be the rivet pitch to give good results.

6. How should the gage glass be put on a boiler?

A. The Massachusetts rules state each boiler shall have a water glass, the lowest visible part of which shall be above the fusible plug and lowest safe water line. The glass should be attached to a water column which has free connections to steam space and to the water space, above and below the water line respectively. The glass itself should be provided with fittings having shutoff valves and a blowoff cock at the bottom so that the glass can be blown out through both the water and steam connections.

7. If too little air is admitted to a furnace, what is the result?

A. Combustion will be incomplete, as there is not enough oxygen supplied to burn the coal and a test of the flue gases will show a high percentage of carbon dioxide, but also a large percentage of carbon monoxide or incompletely burned gas which causes large loss of fuel value.

8. State the advantages of superheated steam.

A. There is considerable difference of opinion about the advantage of superheated steam and the amount of superheat which is desirable. The chief advantage is to prevent condensation of the steam when it is first admitted to the cylinder of a reciprocating engine. There is also the advantage that a smaller weight of steam will suffice to fill the clearance space of the engine, and as the steam travels at high velocity it is possible to use a somewhat smaller steam pipe for a given allowable drop in pressure. In the case of steam turbines, superheat avoids the formation of moisture in the steam while it is passing through the turbines and thus reduces the friction of the steam against the vanes, guide plates and nozzles.

9. How is the total stress on a flat surface held by stays found?

A. Multiply the area of the surface to be stayed in square inches by the pressure in pounds per sq. in. and the result will be the total pounds to be cared for by the stays.

10. Draw an indicator diagram showing one stroke with the expansion line showing the effect of a leaky piston, the admission line showing leaky valves and too much compression shown in the cylinder.

A.

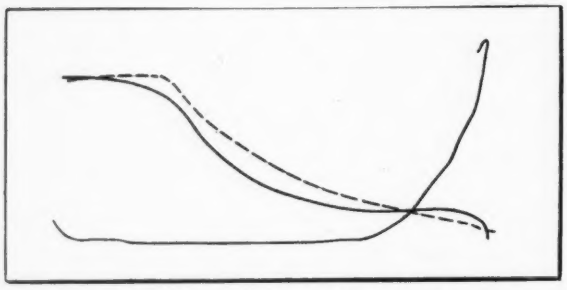


DIAGRAM ANSWER TO QUESTION 10

11. What is the horsepower of an engine 16 in. in diameter, 32-in. stroke, 80 lb. mean effective pressure, and 90 r.p.m.?

A. The rule is: Multiply the mean effective pressure by the length of the stroke in feet, by the area of the piston in square inches, and by the revolutions per minute, and divide this by 33,000. This is for a single-acting engine, and for a double-acting the result would be multiplied by 2. In the problem given the stroke is 32 in. or 2⅔ ft.; the area of a 16-in. piston is 201.1 sq. in. We then have $80 \times 2\frac{2}{3} \times 201.1 \times 90$, and this result divided by 33,000 gives as the answer 117 hp. for single-acting, or twice that for double-acting.

12. State the difference between throttling governor and automatic governor in action.

A. The throttling governor reduces the pressure of the steam as it enters the cylinder, thus cutting down the height of the indicator diagram and therefore lowering the mean effective pressure. The automatic governor changes the point of cutoff, thus shortening the steam line, lowering the expansion line, and in that way lowering the mean effective pressure in the cylinder.

13. What is a cam? What is its use?

A. A cam is a piece attached to a rotating shaft in order to give back-and-forth motion to some other part of the machine. Usually this motion is somewhat irregular, requiring frequently a quick motion in one direction, then a pause and then a quick motion in the other direction and a pause, but any series of motions may be secured by changing the shape of the cam. It is used for driving the valves of steam engines, for making the changes of piston in automatic machinery, and in general for giving any kind of irregular motion from a rotating shaft.

14. How would you proceed to set a piston valve?

A. This is fully explained in the January 1, 1913, issue of Practical Engineer, page 13.

15. What is the advantage of the drop cutoff as used in Corliss engines over the riding cutoff used in slide valve engines?

A. A drop cutoff can be arranged to give quick opening and closing of the valve, and with the mechanism as used in the Corliss engines the opening and closing of the steam valves on the opposite ends of the cylinder can be regulated independently of each other; whereas in the riding cutoff the motion is slower, and if a solid cutoff valve is used, the cutoff cannot be regulated independently for the 2 ends of cylinder.

16. Why is the economy of an engine never expressed in pounds of coal?

A. The number of pounds of coal burned per horsepower-hour may depend quite as much on the efficiency of the furnace, the boiler and the steam piping as on the action of the engine itself. It would therefore be unfair to express the economy of the engine in pounds of coal per horsepower-hour. It is frequently the case that the economy of the entire steam plant is expressed in pounds of coal per delivered horsepower-hour or per kilowatt-hour delivered to the switchboard, but this shows the over-all economy of the plant from coal pile through to available power. The engine is only one step in the transformation.

17. What is meant by initial pressure?

A. This is the pressure in pounds per square inch of the steam as it enters the cylinder of the engine, and is so called because it is the pressure at the beginning of the stroke.

18. What is the advantage and disadvantage of a keyed eccentric?

A. In the keyed eccentric there is no possibility of the eccentric slipping on the shaft and thus disarranging the action of the valve. On the other hand, a keyed eccentric makes it impossible to change the amount of lead on the engine and this is sometimes desirable, due to change in steam pressure, the wear on the valves, and valve rod, or in changing the dimensions of the valve itself to meet changed conditions.

19. Is it possible to maintain a perfect vacuum in an engine?

A. A perfect vacuum cannot be maintained anywhere. In an engine cylinder it is impossible to get anywhere near a perfect vacuum because of the leakage of air past the piston rod packing, through the valves, etc., and the fact that there must be a certain drop in pressure between the cylinder and the condenser to get the steam to flow.

20. Is it advisable to lift the brushes off the commutator while it is in motion?

A. If the machine is not generating voltage or supplying current, lifting of the brushes will do no harm. If, however, the brushes are carrying current,

it is not a good plan to lift them off the commutator because this will cause a spark when the current is broken which is liable to pit the commutator and start roughness.

21. Can a commutator be taken off when worn?

A. In most dynamos the commutator is fastened to the shaft by a key or else is mounted on a hub on the armature spider. In such construction the commutator can be removed when it is worn and a new one substituted, the leads being, of course, disconnected before the commutator is removed, and fastened to the commutator in proper position after the new one is in place. Where the commutator parts are held together by collars screwed on the shaft itself, as was sometimes done in the older designs of small machines, it is a very difficult thing to remove a commutator and put on a new one, as the commutator must be thoroughly baked after it is assembled and tightened up.

22. What causes a dynamo to motorize?

A. If the voltage of the dynamo gets below that of the line to which it is connected or below that of other dynamos connected to the same line, current will be sent backwards through the dynamo from the source having the higher voltage, and this current flowing in the opposite direction to the electromotive force generated by the dynamo will cause it to act as a motor. The lowering of voltage may be caused by a lowering in speed of the prime mover which drives the dynamo, or it may be caused by a weakening of the field, either through the insertion of too much resistance in the field circuit or a short-circuiting of part of the field coils.

23. If part of the insulation should be worn off a live wire and wire come in contact with metal, what would happen?

A. If the circuit is not grounded at any other point, there may nothing happen. The probability, however, is that if a ground like this occurs at any point on the line there will be sufficient ground at some other point so that the machine or the transmission line will be practically short-circuited and will either blow the fuses or throw the circuit breakers on the generator panel, or on the feeder panel. If the wire is too small to stand the current that the fuse or the circuit breaker will carry, the wire will probably fuse against the metal and eventually burn off, leaving a swinging end.

24. What causes the brushes of a dynamo to spark?

A. There are various causes of sparking. Some of the most common are a rough commutator, a brush which does not fit the commutator, a brush out of position, so that it is not at the neutral point, too much current being drawn through the brushes so that the commutator or brushes, or both, are overheated.

25. How would you know when to move the quadrant of a dynamo?

A. If the brushes are sparking lightly and the commutator shows no roughness, it is well to try moving the brushes back and forth to find the point at which the sparking will cease or be lessened.

26. How do you determine the head pressure of an ice machine?

A. This is usually shown by a pressure gage attached to the high-pressure side of the condenser or to the line leading from the condenser. A thermometer may be used to show the temperature in the high-pressure side, and in this case the pressure can be found from a table of the properties of ammonia which is made up the same as a table of the properties of saturated steam.

27. What is the difference between single and double-acting ammonia compressors?

A. In a single-acting compressor only one end of the piston is active in compressing the ammonia gas. In the double-acting, both ends of the piston are active. The single-acting is usually of the vertical type and frequently has the inlet valves located in the head of the compressor piston. The double-acting are usually of horizontal type, and have, of course, inlet and discharge valves separate and located in the head of the cylinder.

28. What is meant by the terms Ammonia Absorption Plant; Brine System; Direct Expansion System?

A. The ammonia absorption plant is one in which the ammonia gas is absorbed in anhydrous ammonia at a low temperature, and is then pumped into a high temperature vessel where the ammonia gas separates from the liquid, passes through a series of pipes and is condensed by cooling water and then passes through an expansion valve where it takes up heat. The brine system is used for the distribution of cold, so to speak. That is, ammonia or other refrigerating medium is used by expansion to cool a large body of brine and this brine is pumped through a series of pipes, taking up heat as it goes from the surrounding mediums, and then flows back to the cooling tank. In a direct expansion system the ammonia is allowed to expand in coils which are placed directly in the room to be cooled and takes up the heat directly. The ammonia gas which has taken up heat is then pumped back to the absorber or compressor where it is cooled and liquefied to be passed again through the expansion coils.

29. What is the function of the pressure tank and to what part of the plant is it connected?

A. The pressure tank is used in a compression system. Gas leaving the discharge valve of the compressor passes through the pressure tank head and is given a whirling motion and throws out any oil which the gas may have in suspension and the gas then passes on to the condenser.

30. What causes ammonia compressors to burst?

A. The same that causes any vessel to burst, namely, the pressure becoming too great for the strength of the containing vessel. The cause of the rise in pressure is usually that the compressor gets too hot from the stoppage of the supply of cooling water, or, in case of a compressor without a safety head, a charge of liquid ammonia may be drawn into the compressor and caught between the piston head and the compressor head. The action is the same as that in a steam engine when a shot of water is taken from the steam pipe.

Tallow in Cylinder Oil

WHAT per cent of tallow oil should cylinder oil contain for an 85-hp. engine, boiler pressure 100 lb., 80 r.p.m., under normal conditions? A. F. W.

A. Five per cent of acidless tallow compounded, hot, with 95 per cent by volume of a good mineral cylinder stock, will give good satisfaction under the conditions you describe. The mineral oil should be free from tarry matter; flash point, 525 to 550 deg. F.; fire point, 600 to 625 deg. F. Philip A. Moore.

Problems For Discussion By Readers

What Would You Do If You Had These Conditions To Meet?

Length Required to Shorten Belt

REPLYING to W. L. B., page 857, Sept. 1 issue, regarding the cutting of belts, single, double and 3-ply when they are new, so when applied they will be of the proper driving tension, there is no set rule for this that we know of in the belting trade, owing to the vast difference of drives, size of belts, strength of pulley and diameter of shafting. Normal conditions will allow a shortage of 2 in. to every 10 ft. up to 30-ft. lengths, but should the belt be, say, 6 in. wide and 50 ft. long, it would have to be cut about 15 in. short to make it tight enough when applied. In double belts under the same condition, you would take from 10 to 12 in. for stretch. In large double and 3-ply belts, it is safe to cut 2 ft. short on the length of 100 ft., as it must be remembered the belt is elastic and should it be cut off to tape line measurement, its own weight would cause it to stretch so there would be insufficient tension to drive the power.

Belts running horizontally with slack side on the bottom have to be put on at a greater tension than when the slack side is on the top. Heavy double belts running in a vertical position have to be kept under a harder tension to prevent them from slipping and burning by dropping away from the lower pulley, so while all leather is not alike in elasticity, neither are the places under which it is applied; we find it must be as a rule left to the judgment of the man who puts on the belting, just how much short he wants the new belt cut to meet his conditions.

The 21½-in. double belt referred to in yours, which you state is going to be made into a 3-ply, has, no doubt, contracted considerably since taken off the pulleys to have a third ply put on; just what this amount might be it is impossible to state.

F. J. Stanley.

Time to Empty Tank

REFERRING to tank problem in Practical Engineer, page 807, for Aug. 15, 1913, we shall take it that the tank is 8 ft. diameter, 10 ft. high, standing on end, and that all the 4 pipes are at the bottom. In the formula

$$t = \frac{2A}{ca\sqrt{2g}}\left(\sqrt{H} - \sqrt{h}\right)$$

t = Time in seconds for water level to drop from H to h.
H = Head on orifice in feet at beginning.
h = Head on orifice in feet at end.
A = Cross-section of tank in square feet
a = Area of orifice in square feet.
g = Acceleration due to gravity.
c = Constant for multiplying theoretic discharge to give actual discharge.

The value of a in the given problem will be the sum of the 4 pipe openings, 6.90 sq. in. or 0.048 sq. ft.; c can be approximated as an average for the 4 different sizes of pipes from Hydraulic Table 17, Merriman's "Treatise on Hydraulics," assuming the discharge through the pipe openings to be the same as that through a circular vertical orifice—call c = 0.603.

A = 50.25 sq. ft.
g = 32.
H = 10.
h = 0.

$$t = \frac{2 \times 50.26}{0.603 \times 0.048 \times \sqrt{64}} \times (\sqrt{10}) = 1370 \text{ sec.} =$$

22.9 min.

Another method of solving this problem makes use of the table on page 713, Kent's Mechanical Engineer's Pocketbook, edition of 1910.

The discharge through a 2-in. nozzle under a constant head of 10 ft. is 0.553 cu. ft. per sec.; through 1½-in. pipe 0.312 cu. ft. per sec.; through 1¼-in. pipe 0.173 cu. ft. per sec.; through 1-in. pipe 0.138 cu. ft. per sec. Through all 4 pipes the theoretical discharge is 1.176 cu. ft. per sec. Using the same constant as above, 0.603, the actual discharge will be $1.176 \times 0.603 =$ 0.709 cu. ft. per second. The volume of the tank is 502.6 cu. ft. and the actual time required for the 4 pipes to discharge the given volume of water under a constant head of 10 ft. is $502.6 \div 0.709 = 709$ sec. or 11.7 min.—the time required for emptying the tank under a falling head is twice that required to discharge the same amount of water under a constant head, so that the 11.7 min. should be multiplied by 2, giving 23.4 min., which comes fairly close to the time derived by the former solution.

David Fliegelman.

Relief Valve to Prevent Valve Rattle

SLAPPING of the valves complained of by W. L. B., page 857, Sept. 1 issue, can be cured by attaching a relief valve between the throttle and steam chest. This valve can be, and is often operated by hand, or can be such a valve as is used on the steam chests of locomotives.

As you do not state size of steam pipe and whether the engine is single or double cylinder, it is not possible to designate size needed. Generally a 4-in. steam pipe requires a 2-in. relief.

J. L. Stewart.

Length of Indicator Cards

ON page 807 of Practical Engineer for Aug. 15 was a question in regard to the length of indicator cards. Following are some reasons why indicator cards may vary in length: Indicator card not being properly stretched over drum will cause the diagram to be too short. By using too much pressure on the pencil the card may be stretched so as to vary the length. If the indicator is loosely connected it is probable that the cards will vary in length.

John M. Leitch.

WATER HAMMER IN ENGINES

AT the works of H. Bollinckx & Co., of Belgium, a series of tests have been carried out on a single cylinder engine, to determine the effect of water hammer and how it is produced. The engine was 27½ in. stroke, by 13.7 in. diameter, running at 158 r.p.m., and taking steam at 7½ atmospheres pressure, developing 140 indicated hp. The admission varied from zero to 55 per cent, the exhaust was at 90 per cent of the forward stroke, and compression began at 75 per cent of the return stroke. Clearance was 3 per cent of the piston displacement. The cylinder was disconnected from the condenser, and exhausted into the air, the piping having a pitch away from the engine to give a freer flow of water from the cylinder.

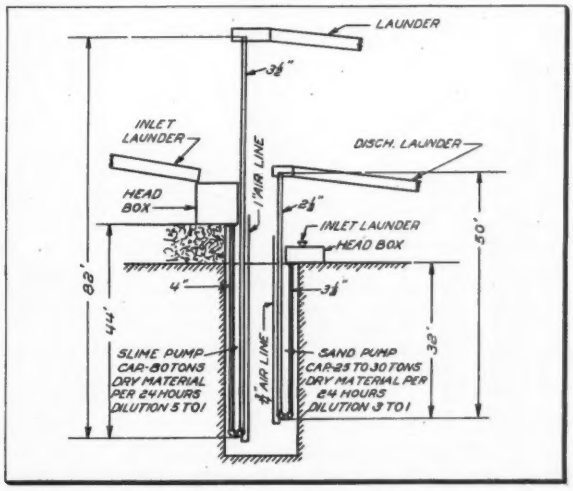
Three series of tests were conducted, first with the piping as ordinarily used, and for a number of different degrees of cutoff, but no water hammer in the cylinder was observed. In a second series of tests, a pocket was made in the steam supply pipe, which would hold about 13 gal., and this was so connected that after the engine was up to speed, the gate valve from a third boiler could suddenly be opened, allowing the water to fill this pocket completely. When this took place, the water came through the cylinder in successive jets, not in a continuous stream. In a later test, when the steam gate valve was opened as rapidly as possible, the steam jacket, as well as the entire steam supply was filled with water, the water still passed through the cylinder and came out in spouts, the first jet being thrown some 65 ft., and the discharge piping received a shock which ruptured one of the joints and made a gap of some 10 in. between the pipes. In none of the tests, however, was there any injury to the cylinder or the joints in the engine, but the size of the water jet increased with the lateness of cutoff.

In the third series of tests, the steam for the cylinder, instead of passing through the jacket as in the second series, was sent direct to the steam chest, and all sorts of tests were tried, but in all cases it was found that water which entered the cylinder during admission ran out of the exhaust pipe without causing trouble, no matter what the amount of water or load on the engine. This was for an engine having horizontal piston valves with trip gear for admission and positive gear for exhaust, and the exhaust valves placed at the bottom of the cylinder. The exhaust valves have a larger cross section than the admission valves, and were open for the entire stroke, while the admission valves were open not over half the stroke, so that there was free chance for the water to go out. If the water had been confined between the piston and the cylinder head, the results would, of course, have been different.

The conclusions reached as the results of these tests were as follows: In single cylinder engines of the type described, water hammer can occur only when the discharge piping is not thoroughly blown out; water then returns to the cylinder, especially when the engine is running light, so that the pressure at the end of expansion is lower than that in the discharge piping. To avoid hammer, a free exhaust, discharging into air, should be placed at the bottom of the cylinder, with a pocket of large capacity in which water may accumulate, a method by siphon or trap for taking the water out of this pocket. For single cylinder condensing engines, water can accumulate in the pipe between the condenser and the cylinder, which will thus act as a pocket, and if precautions are not taken, the water may be sucked up into the cylinder and produce water hammer. Such an accident is particularly probable when starting up, or when suddenly throwing off a large part of the load. For such an installations the Bollinckx Co., uses a steam loop continuously to blow out the pocket in the exhaust pipe. Usually water hammer in this type of machinery is due to defective working of the air pump, but it may be caused by a mistake of the engineer who, while slowing up the engine previous to stopping, forgets to close the water injection to the condenser so that water rises in the condenser and may work over into the cylinder. To avoid such water hammer, provide a drain in the exhaust piping at its lowest point to carry off all water. Provide, also, a float vacuum breaker actuated by the water level in the condenser so that the vacuum will be automatically destroyed in case water rises beyond the safe level.

AIR LIFT PUMPS

IN a mine in Mexico, where there was considerable trouble with other forms of pumps, the air lift was finally installed to handle the sand and the slimes from the mills. Two lifts were used, one with a 2½-in. lift pipe having 65 per cent submergence, the tube discharge being lifted 18 ft. The other lift was a 3½-in. pipe with 54 per cent submergence and an effective lift of 38 ft. It was thought best to have the well pipes of generous dimensions, and accordingly a 3½-in. well pipe was laid in the lower lift, and a 4-in. pipe in the larger one.



DIAGRAMMATIC SKETCH OF ARRANGEMENT OF 2 AIR LIFTS FOR MINE WORK

During 2 yr. they were looked at but once, and the repairs consisted of 2 nozzles and an 8-ft. length of 2½-in. pipe, for the 2 lifts. The lower or sand lift was plugged up at one time, but by closing the inlet or outlet and turning on high-pressure air the obstruction was easily removed. The original air pressure as figured was 25 lb. per sq. in., but better results were had with 28 lb. The consumption of air varies from 2½ to 3 cu. ft. for each cubic foot of sand or slime lifted depending on the dilution of the material. For the final lift of 38 ft., a minimum dilution of 5 to 1 is necessary to give good results. The lower or 18-ft. sand lift is run on a 3 to 1 dilution to avoid excessive handling of solution.—Colo. School of Mines' Mag.

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USE AND ABUSE OF REFERENCE MARKS

After setting valves or determining the position of the piston with reference to the crosshead, it is always well to get reference marks, which can be used to check up in future operations.

There is, however, a tendency on the part of some engineers to cover their machines with all kinds of marks which are unintelligible to anyone else, or even to the one who made them after he has had time to forget what they mean. Careless men in the handling of machinery will also make dents and scratches which either obliterate the useful reference marks, or confuse the whole situation.

Recently a young engineer took charge of a plant where his predecessor had been of the kind which leaves its trademark, in the shape of prick punches and bruises on everything which it touches. In the course of time it was necessary to remove the piston, and as the rod was screwed into the crosshead, and someone had used a Stilson wrench on the rod, it was heavily scored, and in addition there were a great number of prick punch marks along the rod and on the crosshead, where tram rods had been used. The engineer set his dividers to a mark in the rod and one on the crosshead, then scratched the dividers in the floor, to make a record of the distance, and left them on the window sill with other tools.

When the piston was being replaced, a helper reached for the dividers, dropped them on the floor and then looked for the scratch mark which meantime was rubbed out by the walking about. The dividers were tried and the distance corresponded to that between a prick punch mark on the rod and one on the crosshead, so it was taken to be correct and the jam nut was tightened up.

When the engine was started, owing to clearance between crosshead and stop guides, and the fact that the rod had been set too short, the piston came up against the crosshead, fortunately without force enough to break things, but enough to pound and spring the piston rod up and down at each stroke. It was necessary to run back the jam nut and find the proper position of the piston, by taking off the cylinder head and measuring up the clearance. After it was all done, the young engineer concluded to draw-file his piston rod in order to remove all marks, then to work out the marks on the crosshead, and to start with a fresh set of marks, which had nothing to confuse it.

This is only to show that where a great number of marks, both prick punch, Stilson wrench, pliers and hammer bruises are made all over the machine, it not only spoils the surface of the machine, but also defeats the purpose for which the marks are made. These marks should always be made in an inconspicuous position, so that they will not injure the appearance of the machine and should also be placed where they will not be likely to be effaced in the course of cleaning and polishing. Also, the distance between marks should be prick-punched on some part of the frame where they will be out of the way as a matter of permanent record.

ASSISTANCE

No matter how long the operating engineer has been on the job, he is constantly being brought up against new problems that keep him studying and cause him to look to others for assistance. These days of high steam pressure bring about conditions that are quite different from the ones of earlier times.

A recent example that came under our observation, shows how a little assistance that was just beyond the experience of the old engineer explained away troubles that would have caused much worry and the expenditure of considerable money.

Water for boilers was obtained from an artesian well that produced a hard water, but which was successfully treated with boiler compound. A second well was drilled and at the same time new boilers were installed and the pressure raised. Boiler compound had, up to this time, done its work well; but after the change, there appeared in the boiler a substance that was called sand, and the amount of it was large. The engineer called it sand and it looked and felt like sand. It was thought to come from the new well and plans were made for the construction of filters to get rid of this troublesome stuff. An inspection of the substance under the microscope of the chemist at once showed it to be composed of crystals of calcium sulphate and no sand was visible. A study of the water under the new conditions at once explained the cause. The higher pressure brought the heat to just the point where this particular chemical was precipitated, which did not occur under the lower pressures. This gave operating conditions that were totally unlike the former ones and required quite different treatment in the boiler. The old engineer, with all his expertness, could not have anticipated this condition, yet it required only a few minutes of the chemist's time to solve the difficulty and stop the useless expenditure of money for apparatus that could not accomplish the desired result and to formulate a line of treatments that boiler compounds could not help. They were doing all that was expected of them.

The moral of this story is quite plain and is to this effect: that the operating engineer must always be a student. New conditions are arising that are outside his experience and while evident to his brother in the chemical line, yet they are to him as unknown as is his art to the chemist. Discussion of such experiences and the remembrance of such discussion is the valuable result that comes with craftsman's journals and from association meetings.

BOILER INSPECTION

Speaking of the need of license law, why not at the same time a law to compel the inspection of boilers for every high pressure steam plant of any description before the owner is allowed to put it into service; and to make such inspection necessary at least once or twice a year? At Alva, Okla., recently occurred a forceful argument as to the necessity for such a law.

About a month ago a boiler, said by an old time inspector to be of a type discontinued over 15 yr. ago, exploded, killing one man and seriously injuring another. A year ago this boiler bagged badly in a large flue, the boiler being of return-tubular, traction engine type. The owner pulled it into Alva and took the machine to the Alva Machine Works and ordered the bag driven back. The manager of the works looked the boiler over and condemned it as unsafe for further service as he knew it to be a secondhand machine purchased several years previous and even then in bad condition. Upon this the owner borrowed a jackscrew and placing it against the bag forced it back as best he could, the metal being cold.

The day previous to the explosion an ex-inspector passed by when the machine was working at 155 lb. pressure and told the operating engineer that it was unsafe and the operator quit that night. The inspector also told the owner that he was doing a dangerous thing and advised him to lower his pressure to at least 130 lb. and even at that there would still be great danger.

On the following morning, after the original engineer had quit, an inexperienced man was put on the engine with a helper to get up steam. The owner claims that there was only 65 lb. but no one knows what the pressure was when the explosion occurred. The engineer who had quit went to the man operating the boiler and to the owner, telling them to draw the fires and get away while they could, but was laughed at for his fears and left. He was gone 15 min. when the old bag began tearing and an instant after broke lose almost from end to end, blowing the new operator who was in charge of the fire box 180 ft., and scalding the helper. Fortunately the rest of the men had heeded the warning and kept back.

Fire from the fire box was blown into the stacks of wheat, destroying 3 of them, and burning the thresher, entailing a property loss, considering the boiler and engine as practically worthless, of about $2000.

On inspection it was found that the fusible plug had melted out at some time and a tooth from the thresher cylinder had been screwed into the machine. It is easy to see where at least one cripple and one killed could have been saved with a proper inspection law in force.

Of course, boilers will sometimes explode, spite of all precautions, but in this case there was plenty of warning, and no reason why risk should have been taken, except the avarice of the owner, as the boiler should have gone to the junk heap years ago, and would have under any proper system of regular state inspection. It is well to have license law, for the protection of operators, the insuring of proper care of the plant and the safety of the public, but with it must be linked a boiler inspection law, to make certain that competent operators shall not be placed in great danger through the cupidity or ignorance of the owners, and this danger is even greater in portable and small plants, than in the case of large power stations.

SILVER ANNIVERSARY OF THE AMERICAN BOILER MANUFACTURERS' ASSOCIATION

FOR months the plans were in the making; by the officers of the A. B. M. A., to get a series of valuable papers and discussions, and by the supply men, to arrange, in conjunction with the local committee, the elaborate entertainment. And the plans were well perfected and carried out, from the first address of welcome by Mayor Baker on Monday to the last toast at Thursday evening's banquet.

In all lines of manufacture, competition and increasing cost of materials and labor are compelling a careful study of how to obtain greatest effectiveness, and this spirit was the keynote of the meeting. It was manifest in the desire to bring about uniform specifications for boilers in different states and thus do away with the burdens imposed when needless differences in state laws and city ordinances require great variety in materials and methods of manufacture. Also in the keen interest displayed in the papers on Shop Efficiency and Factory Costs and the lively discussion which these evoked.

Growth of the Association and its increased influence were manifest in the large attendance at the meeting of both boiler manufacturers and those who supply them with material and tools and a still larger attendance in future years was made certain by the thoroughly enjoyable and profitable meetings and outings.

Monday

WELCOME to Cleveland was extended by Mayor Baker and fittingly accepted by President E. D. Meier, after which A. V. Cannon spoke as to the status of Uniform Boiler Specifications before the law, and gave an idea of what could be accomplished and the way to go about it. As a matter of law, a federal statute cannot be passed which would accomplish the desired result for such a law could apply only to boilers made in one state and shipped into another, and this would not avoid or displace regulations of a state or city as to boilers to be used in that state or city.

It is necessary, therefore, to influence legislation in each state or city so as to bring about uniformity in such laws, ordinances and rules as established by the different communities, and the adoption of a uniform specification by the manufacturers gives a basis for action by the legislatures and commissions which they will be likely to give careful consideration.

Monday evening was devoted to a reception at the Hollenden Hotel to members, guests and their ladies, who, by the way, received continuous courtesies throughout the meeting; an automobile trip on Tuesday, theater party on Tuesday evening in conjunction with the men, who also acted as adjuncts to Wednesday's steamer trip to Cedar Point, and a shopping trip followed by a theater matinee party on Thursday.

Boiler Specifications

THESE were the main points of interest on Tuesday at both sessions. The Committee on Uniform Specifications and Construction of Boilers made its report which confirmed the recommendations of last year, given in Practical Engineer for April 15 issue, 1912, and expressed the opinion that general principles and features of construction, only, should be embodied, leaving details to be varied to suit different localities; also that in all laws and rules, progress should be provided for by the power to amend rules on 60 or 90 days' notice as changes might be found desirable. At the meetings, the National Association of Tubular Boiler Manufacturers was present in joint session and the feeling was unanimous that in securing uniformity in specifications and laws the 2 associations could and should work together.

The National Association, composed of 34 makers of tubular boilers has adopted a standard of material and design for its product and a list of standard dimensions of sizes which will be given in full in an early issue.

The opinion of the speakers was the common sense view that boiler material should be specified and used according to its strength, ductility and chemical make-up, as shown by tests, rather than by brands; and it was recommended that plate be stamped to the nearest 100-lb. tensile strength and always in 3 places so located as to remain on the sheet after cutting and forming, that the figures may be readily seen by the inspector.

For the framing of a proposed uniform law the meeting adopted the report of the committee, that a special committee of 5 be appointed to confer with the committee of the National Conference on Uniform Laws and to consult with a lawyer in order to get proper and legal wording for the law.

Mr. Kellogg, president of the Tubular Boiler Manufacturers, showed the impossibility of manufacturing or even ordering materials in advance of securing an order on account of the diversity in requirements of states and cities, and the consequent increase in cost of boilers to buyers without any corresponding added value. He showed that Indiana had passed a law along the line of the National Association's standards and other states were taking time to go over them carefully rather than hurriedly add to the existing diversity, which shows the value of having a uniform standard agreed upon by those most familiar with the industry.

Wm. M. Taylor of the Chandler & Taylor Co., emphasized the value of a standard which legislative commissions may use as a basis, and pointed out that the Massachusetts and Ohio Rules cannot become universal for political reasons and because of expense involved in inspection. The insurance companies will always do a considerable and increasing part of the inspection which cuts down the state fees, hence the fund from which the expenses of the state inspection are paid, and changes on 60 to 90 days' notice are feared by local political bodies.

Readiness of inspection boards to cooperate at all times, and their desire for suggestion and criticism were voiced by C. H. Wirmel, chief inspector of Ohio. He also took a dig at the boiler and steel men for their lack of interest when notified of a meeting of the state inspection board and invited to attend.

Inspector Baumhart stated that in his experience the use of thick plates had nothing to do with leaky seams. These are due to formation of scale or oil film or else poor workmanship, and thin plates are as likely to have trouble as thick. A very little oil will, however, cause a great deal of trouble.

Efficiency

L. I. Yeomans spoke on Factory Efficiency, stating as the principles, which are the same for all organizations whether shop or power plant: 1. Labor Saving Equipment to reduce hard physical labor to a minimum. 2. Division of Labor to permit specialization and reduce time of performance and increase skill. 3. Determination of Best Methods and Routine and reduce standards to written form so as to leave nothing to guesswork or chance. 4. Supervision, to insure that standards are followed. 5. Arrangement of Equipment to avoid unnecessary labor. 6. Choice of Materials and Apparatus best suited to the work. 7. Incentive to the Men to do their best at all times. 8. Comfortable and Cheerful Working Conditions. He showed that low cost of supervision does not always mean low total cost, as it may result in carelessness in doing work and the use of poor methods. He emphasized the need of adequate storage space for materials near to the point where they are to be used and getting tools and materials on the job before commencing, so that the man doing the work need not be hindered. He advocated the man on the job staying there and the supervisor doing the walking about, both that he may keep track of the work and to save confusion among the men. A chance to increase his earnings materially is the most effective argument to keep each man on his job continuously.

Flange or Firebox

THOMAS E. Durban, general manager of the Erie City Iron Works, in a paper on Uniform Boiler Specifications, spoke of the better boilers and lower costs which could be secured by uniformity and emphasized the fallacy of brands as a method of specifying steel. He showed that from 65 to 93 per cent of the material marked flange steel met all the requirements of fire box steel, and stated that as fire box steel had somewhat greater ductility, it would seem better fitted for flanging in the heads than the flange steel now specified in some rules, while the flange steel would seem quite suitable for sheets. His experience, with which other members agreed, was that uniform requirements should be urged and adopted in all cities and states, and materials specified by what they will do, not by name.

W. C. Connelly, in speaking of Shop Costs, gave 4 per cent as the proper depreciation on buildings and 7 per cent on equipment, but this would be low for power plant equipment. He advocated careful division of all expenses into items to show where there was unwarranted cost and the basing of overhead charge on labor cost rather than on selling cost, the charge for overhead being in his experience 125 per cent of the labor cost. At the close of his address and the discussion, a committee on uniform cost accounting was authorized to be appointed by the president.

As already mentioned, Wednesday was taken up by an excursion to Cedar Point on which much committee work was done and much good fellowship cultivated. Thursday was, therefore, devoted closely to business, committee reports, elections and discussions of policy.

To conclude the pleasant days fittingly, a banquet on Thursday evening closed the program. It was presided over by Colonel Meier in his usual happy fashion, introducing as speakers: M. P. Mooney, H. D. Sayle, Gen. Geo. Uhler and J. H. Porch.

The following officers were elected by the American Boiler Manufacturers' Association on Thursday: President, E. D. Meier, New York, N. Y.; secretary, J. D. Farasey, Cleveland, O.; treasurer, Jos. F. Wangler, St. Louis, Mo.; first vice-president, T. M. Rees, Pittsburgh, Pa.; second vice-president, J. Don Smith, Charleston, S. C.; third vice-president, H. D. Mackinnon, Bay City, Mich.; fourth vice-president, L. E. Connelly, Cleveland, O.; fifth vice-president, R. Joy, Oswego, N. Y.

The twenty-sixth annual convention will be held at New York City some time in September, 1914.

Officers elected by the associate members of A. B. M. A. are: President, J. T. Corbett, J. T. Ryerson & Son, Chicago, Ill.; vice-president, Thos. Aldcorn, Chicago Pneumatic Tool Co., New York, N. Y.; treasurer, D. J. Champion, Champion Rivet Co., Cleveland, O.; secretary, F. B. Slocum, The Continental Iron Works, Brooklyn, N. Y.

Executive committee: W. O. Duntley, Chairman, president Chicago Pneumatic Tool Co., Chicago, Ill.: W. H. S. Bateman, sales agent, The Champion Rivet Co., Philadelphia, Pa., The Parkesburg Iron Co., The Chicago Pneumatic Tool Co.; D. J. Champion, vice-president and general manager, The Champion Rivet Co., Cleveland, O.; George W. Denyven, Arthur C. Harvey & Co., Boston, Mass.; George H. Partridge, Engineers' Catalog, New York, N. Y.; A. M. Mueller, Jos. T. Ryerson & Son, Chicago, Ill.

Following resolutions of thanks were adopted by the A. B. M. A.:

Whereas: The American Boiler Manufacturers' Association, in Twenty-fifth Annual Convention assembled at Cleveland, Ohio, appreciating the warm welcome accorded us in the Sixth City, the iron rival of Pittsburgh, desires to make formal expression of our thanks by unanimous vote to the following:

To the Honorable Newton D. Baker, Mayor of Cleveland, who welcomed us at our opening session in such eloquent fashion and with such keenly sympathetic understanding of our aims and purposes.

To the management of the Hollenden Hotel and of the Cedar Point Resort Company, for courtesies extended and for efficiently looking after our comfort and pleasure.

To the American Shipbuilding Company, through James C. Wallace, through whose good offices our ladies enjoyed the elegant luncheon at the Clifton Club, Lakewood.

To the Board of Supervising Inspectors of the United States Government, who sent us such a courteous and able representative in the person of Capt. M. B. Nelson, Supervising Inspector for the Ninth District.

To his Excellency the Governor of Massachusetts for appointing as his representative George A. Luck, Chairman of the Massachusetts Board of Boiler Rules, whose genial manners made him many friends.

To the representatives of the Ohio State Board of Boiler Rules, Messrs. H. A. Baumhart, Member of the Board, and C. H. Wirmel, Chief Inspector, for their attendance and interest.

To the Local Committee of Arrangements for their careful attention to all details tending to make the convention successful and enjoyable.

To the local and other contributors to the entertainment fund.

And finally to the daily and technical press for reports of our proceedings.

Power Apparatus in Shop and Market

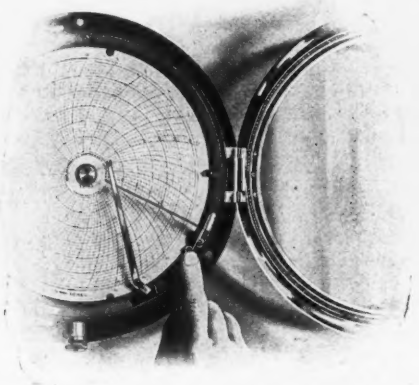
New Ideas In Making, Buying and Selling

IMPROVEMENT FOR RECORDING INSTRUMENTS

AS the demand for high grade, accurate and durable recording instruments has been increasing rapidly during the past few years, the manufacturers of such instruments have endeavored to meet the many requirements, with the result that the up-to-date recording instrument has many marked improvements over the types formerly on the market.

The Industrial Instrument Co., of Foxboro, Mass., which manufactures an extensive line of improved recording instruments, has just perfected a new attachment for recorders, for which patents are pending, and which will interest our readers.

This attachment is called an automatic release pen lifter. It can be attached to any Foxboro improved recorders. It is a simple device consisting of a German silver strip mounted on a special holder, which



AUTOMATIC RELEASE PEN LIFTER

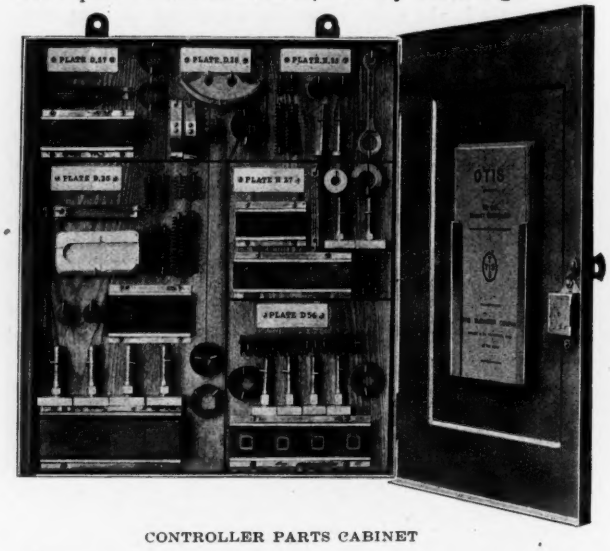
is inserted under a screw head which holds the chart disk. A slight pressure on a small lever brings the strip up against the pen arm and lifts the pen from the chart. Friction holds it in the raised position, thus giving the operator free use of both hands for removing the used chart and supplying a new one. When the door is closed, the pen arm is automatically released and the pen returns to its position on the chart. This automatic feature makes it impossible for the operator to forget and leave the instrument out of commission.

The device is neat, and not only helps in the changing of charts but, what is more important, does away entirely with the necessity of handling the pen arm, with possibility of affecting the adjustment due to a slip or accidental strain. It also prevents accidents commonly resulting in spreading ink where it does not belong and is not desired. It is an improvement which will at once appeal to users of recorders as most practical and useful.

OTIS ELEVATOR CONTROLLER PARTS CABINET

IN order to facilitate and quicken repair service in the event of unexpected breakdowns, or worn parts on elevator controllers, there has been designed by the Otis Elevator Co., New York City, for the convenience of engineers and all who are responsible for elevator maintenance, a useful device shown in the illustration.

This is a compact, strongly made steel box and contains the essential parts of the type of controller furnished with the elevator machine installed from it the engineer may, at an instant's notice, replace a worn part of the controller, and by referring to the



CONTROLLER PARTS CABINET

catalog on the inside of the cabinet cover, order immediately a new part to replace the part removed, keeping the cabinet complete for repair work, at all times.

At present, these cabinets are being manufactured for direct-current controllers only, and are furnished for the familiar types of controllers used with Otis Standard drum and traction machines of all voltages.

DECATUR, ILL., is considering the proposition of installing a sanitary sewage disposal plant to take care of both domestic sewage and industrial waste. Preliminary surveys of the river, from whence Decatur derives its water supply, are now being made by the state water survey and on completion of its report some definite action will be taken.

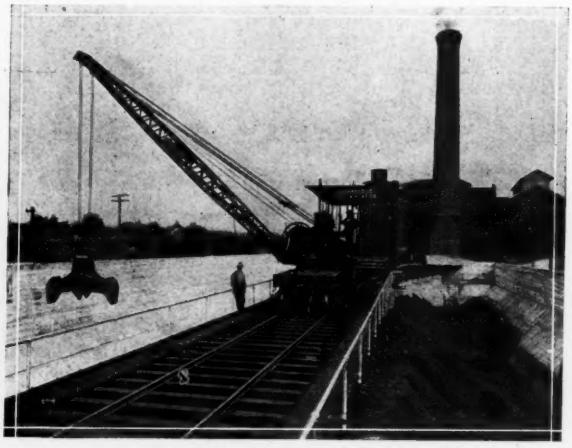
OUR DUTY is to be useful — not according to our desires but according to our powers.

—Amiel's Journal.

COAL STORAGE UNDER WATER

AN unique coal storage plant has recently been erected by the Indianapolis Light & Heat Company of Indianapolis. It is unique in that provision has been made for submerging the coal under the water to prevent spontaneous combustion. The plant has a total storage capacity of 30,000 tons and provides against coal shortage due to strikes at the mines or on the railroads and to car shortage on the railroads.

The plant consists of a large concrete pit as shown in the illustration, 300 ft. long by 100 ft. wide and 28 ft. deep. It is 18 ft. below ground level, having a 10-ft. wall rising above the ground. Below the ground the wall slopes at an angle of 45 deg., this being done only to reduce the cost of construction. This makes the pit 72 ft. wide by 272 ft. long on the bottom. The concrete is from 12 to 18 in. thick and is reinforced throughout with twisted ½-in. square rods to withstand any pressure from water that may rise in the gravel around the pit.



COAL HANDLING CRANE AND STORAGE PIT

Through the middle of the pit lengthways, there is a row of concrete piers placed 15 ft. centers. These piers support a trestle on which there runs a standard gage track. A standard 15-ton Brownhoist locomotive crane travels back and forth on this trestle handling the coal on both sides with a Brownhoist 2 yd. coal grab bucket, suspended on a 40-ft. boom. The crane and bucket are operated by one man from his stand in the cab. Being self-propelled and equipped with M.C.B. trucks, couplers and steam brake, the crane does the switching of the cars off and on the trestle. The coal cars are run out on the trestle with the crane and dumped. And when the coal is required in the power house it is loaded into cars by the crane and carried to the boilers.

Forty-pound rails are imbedded in the bottom of the pit, on 18-in. centers, with ½-in. of the head standing above the surface of the concrete. When the grab bucket is working on the bottom of the pit, the rails prevent the bucket from striking the concrete.

The pit is filled with water up to the ground level, and covers 13,000 tons. The water is pumped into the pit by a 4-in. centrifugal pump, taking the water from the power house supply well, and the water enters the pit at the ground level. Through the center of the pit and beneath the trestle there is a trough 12 ft. wide and 1 ft. deep which serves as a drainage. It is fitted with a drain-pipe which carries the water to either of 2 manholes, one at each end of the pit. The outlet openings are protected by gratings to prevent any coal from entering the drain-pipe.

The pit was designed by Thos. A. Wynne, vice-president of the company, and was built under his supervision. The locomotive crane and bucket were furnished by The Brown Hoisting Machinery Co., of Cleveland, Ohio.

NEW PORCELAIN STRAIN INSULATOR

A NEW porcelain strain insulator of high mechanical and electrical strength, recommended for use on 1500-volt d.c. railway work and on 2200-volt transmission lines, has just been placed on the market by the Westinghouse Electric & Mfg. Co. These insulators are of the interlinking type, making it impossible for cables to separate even if the insulator

FIG. 1. NEW PORCELAIN STRAIN INSULATOR

is shattered. A large creepage distance, provided by the shape of the insulator, makes it suitable for high voltages. The smallest size of these insulators has a flash-over voltage on rain tests of over 13,000 volts,

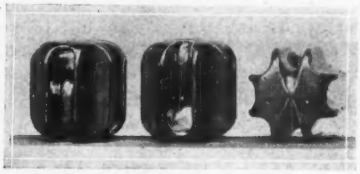


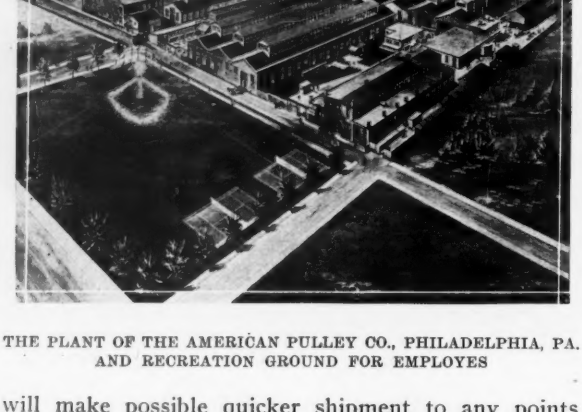
FIG. 2. THREE VIEWS OF THE NEW PORCELAIN INSULATOR

and the larger size, over 20,000 volts. The tensile strength of the larger size insulator is over 23,000 lb., its size is 5 by 4½ by 4½ in. The dark brown color of the glaze aids in avoiding the attention of mischievously inclined persons.

A METHOD OF AVOIDING continual tearing up of the streets is practised in European cities which might well be copied both by municipalities and industrial plants in this country. In Prague, the space under the sidewalk is used for telephone, telegraph and electric light wires, and in some streets also for gas pipes and connections of the buildings with sewers. Each autumn the department of Public Works invites Public Service Corporations to a meeting in which all matters of contemplated improvements are talked over and arrangements made for the opening of streets and putting down of conduits as may be necessary, all to be done at one time so that different companies will not have to tear up the same streets during the year. In Glasgow, before any street is renewed or paved, all departments likely to open the street are notified to give them an opportunity of examining the pipes or making necessary repairs, alterations or renewals before the pavement is laid, thus avoiding what is so frequently seen in this country, the tearing up of a paving which has been down but a short time in order to make some change in an underground conduit or main.

AMERICAN PULLEY COMPANY BUILDING

A NEW building has been added to its plant by the American Pulley Company, of Philadelphia, for the manufacture of steel split pulleys. This new building contains 54,000 sq. ft. of floor space and will easily store 40,000 pulleys for belts but will also be used for storing sash pulleys, bushings and all finished products. The increased storage capacity



THE PLANT OF THE AMERICAN PULLEY CO., PHILADELPHIA, PA. AND RECREATION GROUND FOR EMPLOYES

will make possible quicker shipment to any points either domestic or foreign. The entire structure is fireproof with brick walls, tile roof, concrete floors and metal racks, bins and shelving. In the second story will be an office 80 by 100 ft. into which the staff will move in October.

ALL IN A DAY'S WORK

By E. L. Swapp

IT was 'orribly 'ot in the boiler room,
W'are Fred was a 'eavin the coal;
A lot of it into the ashpit, and
Some into the fire 'ole.
'E was a duck of a fireman, 'e was,
A rip snortin' stoker of 'ell;
'Is feet big and flat as a deadplate; and
'E'd a 'orrible lisp as well.

To run right we needed one fifty o' steam,
Allers shy o' the fifty was Fred;
'An wen things was abuckin', and me feelin' mean,
Hi wish't as the beggar was dead.
The honly odd times as the gages looked good,
Was w'en somethink' 'ud 'appen to stop;
W'en 'e seen 'er araisin', 'e 'd start firin' like 'ell,
Then sit down w'en 'e 'eard 'um go pop.

Hi was fillin' the cups w'en 'e came runnin' in,
Hyes poppin', 'air standin' with fright;
"Hiblowed out thothe column thingth, blatht it," 'e says,
"An' the waterth all sthayed out of thight!
Hi've been pumpin' like 'ell too," the rummy 'e says,
"But it don't theem to do any good;
Hi think ath the boilerth ith leakin'," says 'e,
"Elth the pump ith achurning up mud."

Then hi 'ears a big noise, an' hi says, "That's the pump,
It sure never rains but it pours;
If there's one thing hi likes, it's a tinkerin' with pumps,"
An' hi 'ops it like 'ell through the doors.
Hi shuts hoff the pump, sets the injecter agoin',
An' runs to the boilers a swearin,;
For to see both the water gage glasses was hempty,
Steam 'igh (for oncet) an' fires just a tearin'!

H'ill be bloomin' well shattered an battered, b'gum,
If both chains wan't pulled down on the columns!
Shut tight from the boilers, with drip cocks a leakin',
An' Fred standin' there lookin' solemn!
W'en hi pulls on the chains for to try out the cocks,
W'y the water immediately rose!
Until height hinches showed, just as plain, hi'll be blowed,
As the wart hon the hend of Fred's nose.

"Come 'ither, come 'ither, you blighter," hi says,
"An' get this stuck fast in your nut;
W'en you think you've no water, you make lots o' fog,
Now make steam, an'-see water-you mutt"!
Then hi 'its 'im a smash on the 'ed with the shovel,
An' hi hoffs to the pump, "the blest 'ome of the devil,"
Hi stands in a black 'ole, 'twixt three walls an' a 'eater,
For a nice place to work in, it sure is a beater.

Hi turns, an' hi squirms, 'till hi gets alongside,
With wrenches, an' 'ammer, an' packin' besides;
Then hi takes hoff ees glands, an hi screws hoff ees 'ed
An' 'auls hout ees innards, an sees ees quite dead.
The rod 'ad broke loose from the piston, ker plumb!
So hi telephones hup for the blacksmith to come;
Has we prepared the beggar, hi sings, "boom-de-ay,"
An' we 'ad im hall fixed by the hend of the day.

But hi wisht you'd a 'eard 'wot the bally smith said,
Hevery time 'ees fat 'ed 'it the wall!
An' w'en skinned was ees knuckles, an' two fingers crushed;
W'ot 'orrible things 'e did bawl!
'E cursed, an' 'e wistled, 'e spit, an' 'e tore!
Has 'e 'auled that there piston from hout o' the bore;
Blow me! w'ot 'e'd said would a fair been a treat,
'Ad the blarsted old piston but fell on ees feet.

Well, b'gum hi must leave you', my love to you hall,
If you chans't to meet Fred, don't say nothing at all;
There's all sorts an' conditions of people an trouble,
Some 'as their share single, an' huthers theirs double.
But 'owever it comes, we hall 'ave enough,
Lookin' pleasant is hoften a sweet game of bluff;
An' still it's worth playin', 'elps trouble to duck,
'Ere with 'arty good feelin', hi wishes you luck.

THINK SUCCESS, dream success, live success. Concentrate on one thing—success. Do not try to do 2 things at one time. Do not try to work your hand intelligently while your tongue is wagging on gossip. Talk to your associates after the whistle blows. The malcontent will tell you to talk all you like, for this is your American right; and it is. But if you follow the advice of the croaker, the jealous complainer, you will find your promotion will be delayed, and your pay envelope contain the same amount of currency year after year.—Graphite.

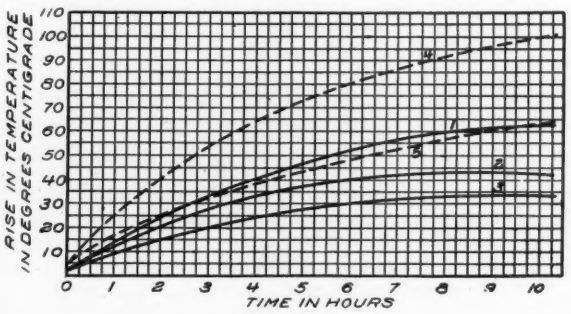
These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should

These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should preserve them. A handy, serviceable, loose-leaf cover in which these tables fit exactly, will be sent you for 30 cents in currency or stamps.

PRACTICAL ENGINEER

TRANSFORMER CAPACITIES FOR MOTORS

Size of Motor Hp.	Kilowatts per Transformer For 2 Trans.	For 3 Trans.
1	0.6	0.6
2	1.5	1.0
3	2.0	1.5
5	3.0	2.0
7½	4.0	3.0
10	5.0	4.0
15	7.5	5.0
20	10.0	7.5
30	15.0	10.0
50	25.0	15.0



CURVES SHOWING RESULTS DUE TO USE OF OIL IN TRANSFORMERS

1. Temperature rise (calculated by resistance method) of a transformer without oil. 2. Temperature rise of same transformer with oil. 3. Temperature rise of the oil. 4. Temperature rise of another transformer run without oil. 5. The highest temperature rise accessible to thermometer, whose actual temperature (by resistance) is shown in curve 4.—Foster's Electrical Engineers' Pocket Book.

PRACTICAL ENGINEER

SIZE OF WIRES FOR A. C. MOTORS

Horse-power	220 Volts, 3 Phase		440 Volts, 3 Phase		Single Phase	
	To Starter	Starter To Motor	To Starter	Starter To Motor	To 110-Volt Motor	To 220-Volt Motor
1					8	12
2					6	10
3	8	12	12	12	5	8
4	4	4	4	4	4	6
5	6	8	10	12	2	4
7½	4	6	8	12	1	2
10	2	6	6	10	00	1
15	00	4	4	8		
20	0000	2	3	6		
25			2	6		
30			0	6		
35			00	4		
40			00	4		
50			0000	2		

FORMULA FOR FEEDERS OVER 100 FT. LONG

$$\text{A (cir mils)} = \frac{P \times 746 \times L \times K \times 1.5}{a \times b \times E \times e}$$

Where P is Hp. of motor; L distance in feet to motor one way; K as shown in the table of Constants; a the efficiency of motor; b the power factor of motor; E the circuit voltage; e the volts drop in wiring. The percentages of efficiency and power factor are used in the formula as decimals. Thus 80 per cent is used 0.80.

Table of Constants—K.

System	Power Factors				
	1.00	95	90	85	80
Single Phase	22	24	27	30	34
Three Phase	11	12	14	15	17

Table of Efficiencies of 3-Phase Motors.

Horsepower	1	5	20	300
Efficiency	.80	.85	.88	.93

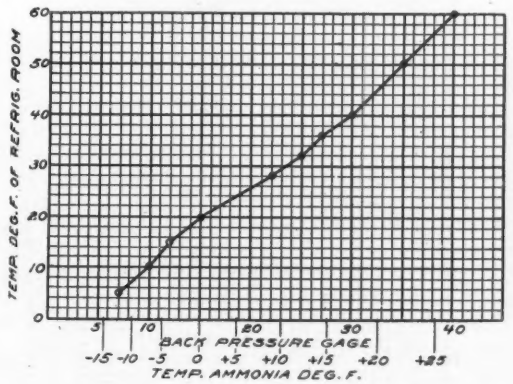
PRACTICAL ENGINEER

STANDARD PIPE

Nom. Size in.	For 1 Ft. Length: Contents Cu. Ft.	Contents U. S. Gal.	Wt. Water Lb.	Surface External Sq. Ft.	List Price	Pressures, Steel Pipe: Bursting	Working, Factor of Safety=6
⅛	.00040	.001	.024	.106	.055	25,182	
¼	.00072	.001	.044	.141	.060	24,174	4,197
⅜	.00133	.002	.082	.177	.060	18,420	4,029
½	.00231	.005	.132	.220	.085	17,490	3,070
¾	.0037	.010	.233	.275	.115	13,704	2,915
1	.0060	.020	.373	.345	.17	12,780	2,284
1¼	.0104	.040	.663	.435	.23	10,140	2,130
1½	.0142	.060	.883	.498	.275	9,000	1,690
2	.0234	.100	1.453	.622	.37	7,440	1,500
2½	.0332	.163	2.072	.753	.585	8,262	1,240
3	.0513	.255	3.202	.916	.765	7,080	1,377
3½	.0688	.367	4.285	1.050	.92	6,366	1,180
4	.0885	.500	5.517	1.18	1.09	5,880	1,061
4½	.1110	.642	6.908	1.31	1.27	5,460	980
5	.1390	.826	8.668	1.45	1.48	5,130	910
6	.201	1.02	12.521	1.735	1.92	4,614	855
7	.269	1.46	16.70	1.996	2.32	4,290	769
8	.348	2.00	21.688	2.258	2.88	4,026	715
9	.436	2.61	27.58	2.52	3.48	3,846	671
10	.548	3.30	34.171	2.81	4.15	3,648	641
11	.660	4.08	41.150	3.08	4.63		608
12	.785	4.94	49.017	3.34	5.07	3,120	520

PRACTICAL ENGINEER

RELATION OF REFRIGERATION TEMPERATURE AND BACK PRESSURE IN AMMONIA SYSTEM

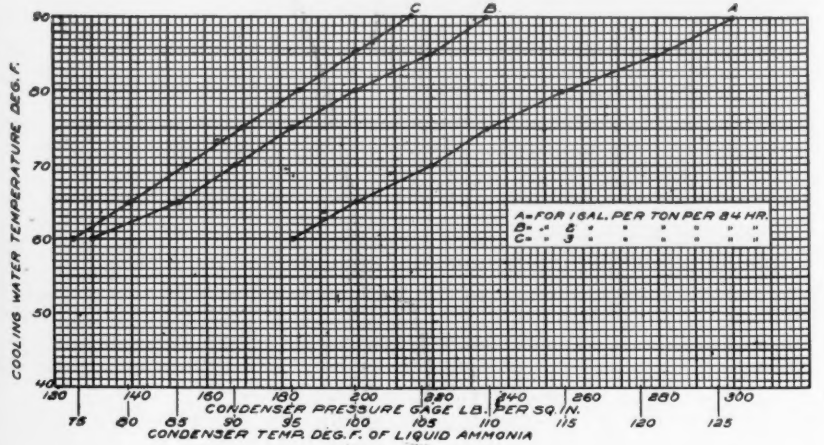


LOSS HEAT FROM BRINE PIPES

Size of Pipe in.	Transmission in B.t.u. per 24 hours, per lineal foot for one degree Fahr. temperature difference between inside and outside of: Bare Pipe O.D. in.	B.t.u.	Cold Water Cork Cover O.D. in.	B.t.u.	Ice Water Cork Cover O.D. in.	B.t.u.	Brine Cork Cover Standard O.D. in.	B.t.u.
½	0.84	9.50	2.62	5.76	3.25	3.84	4.25	3.37
¾	1.00	11.88	2.85	6.00	3.75	4.00	4.75	3.53
1	1.31	14.81	3.31	6.39	4.25	4.26	5.31	3.73
1¼	1.66	18.77	3.75	7.17	4.62	4.78	6.31	3.87
1½	1.90	21.49	4.00	7.90	4.75	5.27	6.90	3.96
2	2.37	26.80	4.62	8.82	5.31	5.88	7.25	4.44
2½	2.87	32.46	5.12	10.47	5.62	6.98	7.87	4.84
3	3.50	39.58	5.62	10.95	6.62	7.30	8.87	5.20
3½	....	45.24	....	.....	....	7.82	....	5.46
4	....	50.89	....	.....	....	8.29	....	6.21

—N. E. L. A.

RELATION OF AMMONIA CONDENSER PRESSURES, COOLING WATER TEMPERATURES AND AMOUNTS OF COOLING WATER


COOLING WATER TEMPERATURE DEG. F.
90
80
70
60
50
40
C
B
A
A=FOR 1 GAL. PER TON PER 24 HR.
B= " 2 " " " " " "
C= " 3 " " " " " "
180 140 160 180 200 220 240 260 280 300
CONDENSER PRESSURE GAGE LB. PER SQ. IN.
75 80 85 90 95 100 105 110 115 120 125
CONDENSER TEMP. DEG. F. OF LIQUID AMMONIA

SINGLE PHASE INDUCTION MOTORS

Hp.	110 Volts: Size of Switch Amps.	110 Volts: Starting Fuses in Amps.	110 Volts: Running Fuses in Amps.	220 Volts: Size of Switch in Amps.	220 Volts: Starting Fuses in Amps.	220 Volts: Running Fuses in Amps.
1	25	25	20	15	15	10
2	50	45	30	25	25	15
3	75	70	45	50	35	20
4	75	85	60	50	45	25
5	100	100	70	50	55	35
7½	150	150	100	75	75	50
10	200	200	125	100	100	65

THREE-PHASE INDUCTION MOTORS

Hp.	220 Volts: Size of Switch in Amps.	220 Volts: Starting Fuses in Amps.	220 Volts: Running Fuses in Amps.	440 Volts: Size of Switch in Amps.	440 Volts: Starting Fuses in Amps.	440 Volts: Running Fuses in Amps.
3	25	25	15	15	15	10
5	50	35	20	25	25	15
7½	50	45	30	25	25	20
10	75	65	40	50	35	20
15	100	100	60	50	50	30
20	150	130	75	75	75	35
25	150	150	95	75	75	50
30	200	200	100	75	90	55
35	200	200	125	150	175	90
40	225	225	150			
50	300	250	175			

STANDARD PIPE

Nom. Size In.	Actual Diam. Ext. In.	Actual Diam. Int. In.	Metal Thick. In.	Metal Area Sq. In.	Metal Wt. per Ft.-Lb.	Threads No. per In.	Threads Tap Drill, In.	Threads Length at Bottom of Full Th'd. In.	Length Entering Fitting In.
⅛	.405	.27	.068	.072	.244	27	21-64	.19	
¼	.54	.364	.088	.125	.424	18	29-64	.29	
⅜	.675	.494	.091	.166	.567	18	38	.30	
½	.84	.623	.109	.249	.840	14	23-32	.39	
¾	1.05	.824	.113	.333	1.130	14	59/64	.40	
1	1.315	1.048	.134	.495	1.678	11½	1 9/64	.51	
1¼	1.66	1.380	.140	.668	2.272	11½	1 31/64	.54	
1½	1.9	1.611	.145	.797	2.717	11½	1 47/64	.55	
2	2.375	2.067	.154	1.074	3.652	11½	2 7/64	.58	
2½	2.875	2.468	.204	1.708	5.793	8	2 11/64	.89	1
3	3.5	3.067	.217	2.243	7.575	8	3 5/64	.95	1
3½	4.	3.548	.226	2.679	9.109	8	3 33/64	1.00	1
4	4.5	4.026	.237	3.174	10.790	8	4 1/64	1.05	1
4½	5.	4.508	.246	3.674	12.538	8	4 17/64	1.10	1
5	5.563	5.045	.259	4.316	14.617	8	5 9/64	1.16	1
6	6.625	6.065	.280	5.584	18.974	8	6 13/64	1.26	1
7	7.625	7.023	.301	6.926	23.544	8	7 7/64	1.36	1
8	8.625	7.982	.322	8.386	28.554	8	8 7/64	1.46	1
9	9.625	8.937	.344	10.03	33.907	8	9 7/64	1.56	1
10	10.75	10.019	.366	11.924	40.483	8	10 33/64	1.68	1
11	11.75	11.00	.375	13.401	45.557	8		1.78	1
12	12.75	12.00	.375	14.579	49.562	8		1.88	1
13	14.	13.25	.375	16.051	54.568	8		2.00	
14	15.	14.25	.375	17.23	58.573	8		2.10	
15	16.	15.43	.284	14.02	62.579	8		2.20	
16	17.	16.40	.300	15.74		8		2.30	
17	18.	17.32	.340	18.86		8		2.40	

CURRENT TAKEN BY DIFFERENT MOTORS

Horse-power	Direct Current Motors: 110 Volts	Direct Current Motors: 220 Volts	Direct Current Motors: 500 Volts	Alternating Current Motors: Single Phase 110 Volts	Single Phase 220 Volts	Single Phase 500 Volts	Two Phase (Four Wire) 110 Volts	Two Phase (Four Wire) 220 Volts	Two Phase (Four Wire) 500 Volts	Three Phase (Three Wire) 110 Volts	Three Phase (Three Wire) 220 Volts	Three Phase (Three Wire) 500 Volts
1	9	4.5	2.0	14	7	3.1	6.4	3.2	1.4	7.4	3.7	1.6
2	17	8.5	3.7	24	12	5.3	11	5.7	2.5	13	6.6	2.9
3	26	13	5.6	34	17	7.5	16	8.1	3.5	19	9.3	4.1
5	40	20	8.8	52	26	11	26	13	5.5	30	15	6.4
7½	60	30	13	74	37	16	38	19	8.1	44	22	9.3
10	76	38	17	94	47	21	44	22	10	50	25	12
15	112	56	25				66	33	15	76	38	17
20	150	75	33				88	44	19	102	51	22
30	226	113	50				134	67	29	154	77	33
40	302	151	66				178	89	39	204	107	45
50	368	184	81				204	102	45	236	118	52
75	552	276	122				308	154	68	356	178	77
100	736	368	162				408	204	90	472	236	104
150	1110	555	244				616	308	135	710	355	156
200	1474	737	324				818	409	180	940	470	208

International Library of Technology

PRODUCTION AND IMPORTATION OF GRAPHITE

NATURAL graphite is the product of different geologic agencies, mostly related to the heat of the molten magma which, during periods of convulsion, has penetrated the overlying rock strata from the earth's interior. It has 2 forms—crystalline, or, as it is known to the trade, flake graphite, which occurs as small flakes disseminated through crystalline schists, and amorphous graphite, which has no grain or structure. Coal beds in some places have been turned into graphite by the confined heat of intruded molten rock, and this natural phenomenon may have suggested the feasibility of manufacturing artificial amorphous graphite, an industry which of late years has become of considerable importance in the United States. Importations of graphite, however, largely exceed domestic production, the figures for 1912, according to the United States Geological Survey, being for the imports 25,643 short tons, valued at $1,709,337, and for the domestic output 2445 tons of natural graphite, valued at $207,033, and 6448 tons of manufactured graphite, valued at $830,193. The island of Ceylon is the greatest contributor to American imports of graphite.

Graphite is a mineral of great and increasing industrial importance and has many uses, though the graphite from any one source or mine is not adapted to all these uses. One of the oldest and most important applications of graphite is in the manufacture of crucibles for use in the steel, brass and bronze, and other industries. Such crucibles must have good tensile strength and for their manufacture a fibrous or flaky graphite is used, the interlocking of the fibers adding to the strength. Ground Ceylon lump graphite is the material most in favor in the United States for making crucibles, although small amounts of American flake graphite are also used. Amorphous graphite has never been successfully utilized in crucible manufacture, except for very small crucibles.

The United States Geological Survey has just published, as an advance chapter from Mineral Resources for 1912, a report on the graphite industry in the United States by Edson S. Bastin, which also includes figures of importations into this country as well as statistics covering other graphite-producing countries.

A copy of the report on graphite may be obtained free on application to the Director of the Geological Survey, Washington, D. C.

NEWS NOTES

GEO. H. TOOD of Minot, N. D., will be granted a franchise for an electric light plant by the city council of Mohall, N. D., and will install the lighting system this fall.

W. E. SANDERS, who, for many years, has been engaged in the steam specialty field as developer, inventor and sales manager, of mechanical rubber goods and other specialties, has become associated with the Paul B. Huyette Co., of Philadelphia, as mechanical engineer.

NELSON VALVE COMPANY, Chestnut Hill, Philadelphia, announces that it has made arrangements with J. W. Carter, 6 Peters St., Atlanta, Georgia, to represent the company. Mr. Carter will carry a stock of all popular sizes and types of gate, globe, and check valves to take care of orders he will receive.

CURRENT FROM THE giant power plant at Hale's Bar will soon be turned on and the wheels of Chattanooga, Tenn., manufacturing plants will be turned by power furnished by the river that flows by their door. Work on the dam is progressing rapidly. If conditions remain ideal for work, the concrete structure will soon be completed.

THE IROQUOIS COUNTY Times-Democrat states that the Central Illinois Utilities Co. has purchased a site near Watseka, Ill., for the erection of a $500,000 electric power station, to be erected and equipped at once, to furnish current for the towns in this section of the state served by the company. The Democrat also states that the capacity of the plant will probably be doubled within a year.

OCTOBER 17 TO 25 the First National Mining Show will be held in connection with the meeting of the American Mining Congress in Philadelphia. The exhibit will be in Horticultural Hall and will include all classes of mining machinery. There will also be exhibits showing methods of operation, methods of safety protection, and collections of minerals and data in regard to the mining industry. Applications for space already received make it certain that the hall will be crowded but every effort is being made to provide space for all representative exhibits which are offered.

CHARLES H. MOYER, for 20 yr. New York manager and chief traveling representative of the Geo. V. Cresson Company, Philadelphia, and in the last few months of its successor, the Cresson-Morris Company, has resigned his position. Mr. Moyer, who is widely known as a specialist in power transmission machinery, was connected with the Geo. V. Cresson Company since boyhood and held various positions at the works before opening the New York office. He contemplates going into business as a special engineering representative and manufacturers' agent, with an office at 90 West St.

AN IMPORTANT PUBLIC IMPROVEMENT undertaken by Mt. Pleasant, Utah, is the power plant now nearing completion in Pleasant Creek Canyon, 4 miles east of town. A cement dam in Pleasant creek, arranged in such a fashion that any danger from floods is minimized, diverts the water, which is carried along the hillside nearly a mile until sufficient fall is possible to give the necessary horsepower in the canyon below where the power plant is. The plant and the line over which the power is to be conducted to town represent a total outlay of between $25,000 and $30,000. It is owned wholly by the city. The intention is for the municipality to purchase the holdings of the private corporation now furnishing light to residents of the place. The new plant furnishes power as well as light.

THE UNITED STATES CIVIL SERVICE COMMISSION announces an open competitive examination for dynamo tender, for men only, on September 17, 1913, at all principal cities of the country. From the register of eligibles resulting from this examination certification will be made to fill a vacancy in this position in the Immigration Service at Ellis Island, New York, at a salary of $900 a year, and vacancies as they may occur throughout the United States in positions requiring similar qualifications, unless it is found to be in the interest of the service to fill any vacancy by reinstatement, transfer, or promotion.

Competitors will be examined in the following subjects, which will have the relative weights indicated: 1. Letter writing (a letter of not less than 125

words on some subject of general interest. Competitors may select either of 2 subjects given), 10; 2. Practical questions relating to the principles of construction and operation of dynamos, 65; 3. Training and experience, 25.

Statements as to training and experience are accepted subject to verification. Age, 20 yr. or over on the date of the examination. Applicants may be examined at any place at which this examination is held, regardless of their place of residence; but under an act of Congress only those who are examined in the State or Territory in which they reside, and who have been actually domiciled in such State or Territory for at least one year previous to the examination, will be eligible for appointment to a position in the apportioned service in Washington, D. C.

This examination is open to all men who are citizens of the United States and who meet the requirements. Persons who meet the requirements and desire this examination should at once apply to the United States Civil Service Commission, Washington, D. C., or to the secretary of the board of examiners at any examination place for application Form 1800. No application will be accepted unless properly executed and filed with the Commission at Washington in time to arrange for the examination at the place selected by the applicant. In applying for this examination the title "Dynamo Tender (Male)" should be used.

THE UNITED STATES CIVIL SERVICE COMMISSION announces open competitive examinations for structural draftsmen, first class and second class, for men only, on September 17 and 18, 1913, at principal cities of the country. From the registers of eligibles resulting from these examinations certifications will be made to fill vacancies as they may occur in these positions in the Isthmian Canal Service, unless it is found to be in the interest of the service to fill any vacancy by reinstatement, transfer, or promotion.

The entrance salaries of structural draftsmen in the Isthmian Canal Service are as follows: First class, $150 a month and upward; second class, less than $150 a month.

Competitors for first class draftsman will be examined in the following subjects, which will have the relative weights indicated: 1. Mathematics (involving algebra, geometry, plane trigonometry, and use of logarithm tables) and applied mechanics, 30; 2. Design and drawing (the design and sketching of columns, beams, girders, trusses, etc., in steel or reenforced concrete), 40; 3. Training and experience, 30.

Applicants must have had 5 years' experience, at least 2 yr. of which must have been in structural drafting and design work. A college technical training will be considered equivalent to 1 yr. of the 5.

Applicants must have reached their 23rd but not their 45th birthday on the date of the examination.

Competitors for second class draftsman will be examined in the following subjects, which will have the relative weights indicated: 1. Mathematics (involving algebra, geometry, plane trigonometry, and use of logarithm tables) and applied mechanics, 40; 2. Elementary design and drawing (elementary design and making scale drawings from sketches and tracing thereof), 40; 3. Training and experience, 20.

Applicants must have had 3 years' experience in drafting and design work. A college technical course will be considered equivalent to 2 yr. of the 3. Applicants must have reached their 21st but not their 45th birthday on the date of the examination. Two days will be required for each of these examinations. Applicants must be physically sound and in good health. Each applicant for the Isthmian Canal Service will be required to submit to the examiner, on the day he is examined, a photograph of himself, taken within 2 yr., which will be filed with his examination papers as a means of identification in case he receives appointment. An unmounted photograph is preferred.

Persons who meet the requirements and desire this examination should at once apply to the United States Civil Service Commission, Washington, D. C., or to the secretary of the board of examiners at any examination place for application Form 1312. No application will be accepted unless properly executed, including the medical certificate, and filed with the Commission at Washington in time to arrange for the examination at the place selected by the applicant. In applying for this examination the exact title, "Structural Draftsman, First Class (Male)," or "Structural Draftsman, Second Class (Male)," should be used.

BOOKS AND CATALOGS

A CONCISE VOLUME, which contains statistics showing the foreign trade of each country of the world during 1911 compared with the previous year, has just been issued by the Bureau of Foreign and Domestic Commerce at Washington. This valuable publication shows the principal articles and their value, entering into the trade of each country and the itemization of the imports from and exports to the United States. The statistics were prepared by American consular officers, and supplemented by other official data. In addition to trade statistics, the grain crops and mineral output of the principal countries are given, thus presenting in compact form the principal features upon which the commerce and industries of the foreign countries depend. The volume should prove highly valuable for reference purposes, having been revised and brought up to date so far as statistics were available. Copies of the book may be obtained from the Superintendent of Documents, Washington, D. C., for 35 cents each.

FOREIGN MERCHANTS CONTEMPLATING THE PURCHASE of American goods always want to know the cost of the article delivered, and the inability or unwillingness of American exporters to quote c.i.f. prices has lost them many orders. To assist exporters in ascertaining delivery charges, the Bureau of Foreign and Domestic Commerce has published a bulletin compiled by Commercial Agent F. J. Sheridan dealing with transportation rates to the west coast of South America, this section of the foreign field being selected because of the trade activity that is expected to follow the opening of the Panama Canal.

The main part of the bulletin is a series of tables giving the freight rates on over 800 articles from inland points in the United States to inland points in Ecuador, Peru and Chile. Freight rates per 100 lb., in carload and less than carload lots, are given to New York from Chicago, St. Louis, Cincinnati, Indianapolis, Cleveland, Detroit, Buffalo, Pittsburgh, Boston, Providence, and Hartford; ocean freight rates per 100 lb. and per cubic foot from New York to Guayaquil, Callao, Mollendo, Antofagasta, and Valparaiso, via the Straits of Magellan and via Panama; and freight rates per 100 lb. inland from Guayaquil to Quito, Callao to Lima, Mollendo to Arequipa, and Valparaiso to Santiago.

Lighterage, transfer, and other charges at the port of New York and at South American parts are shown, together with the cost of marine insurance, and data are also given as to consular fees and regulations and steamship requirements. Comparative tables give the competitive rates from European ports and from New York to South America.

In addition to these features, statistics are furnished to show the character of the goods sold by the United States to Ecuador, Chile, Peru and Bolivia, and for each of these countries general information is given as to area, population, language, currency, postage rates, foreign trade, and distance from New York. Tables of price comparisons give the equivalents in the currency and measure of these countries of prices stated in the money measures of the United States.

The bulletin, in short, is a compendium of practical information for the assistance of merchants who are engaged in the export trade or who contemplate entering the foreign field. Copies of the bulletin (Special Agents Series No. 72) may be obtained from the Superintendent of Documents, Washington, for 10 cents each.

OIL SEPARATORS form the subject of Section C of the Cochrane Separator catalog, issued by the Harrison Safety Boiler Works, 3144 N. 17th St., Philadelphia, Pa. The introduction to this pamphlet contains interesting information regarding the removal of cylinder oil from exhaust steam for the purpose of rendering the latter suitable for heating water by direct actual contact in open heaters or for use in heating or drying systems where the condensate is to be employed for boiler feeding, without danger to the boiler. The remedy recommended in this pamphlet is that the oil be removed from the steam before condensation by means of oil separators of the kind in which a vertically-ribbed baffle is placed across the current of steam, serving both to divert the stream of emulsion which flows along the bottom of the exhaust pipe into a well which the steam current does not enter, also to intercept flying drops or particles carried by the steam current itself. The pamphlet also discusses various applications of separators, and the manner of using them, as in connection with heating systems, paper mills, textile mills, ice plants, etc.

A COMPREHENSIVE PUBLICATION on the conservation and distribution of water for irrigation has just been issued by the Henry R. Worthington Hydraulic Wks. of the International Steam Pump Co., 115 Broadway, New York. The book shows what has been done by irrigation in various sections of the country and then describes a number of pump installations for irrigating systems, giving directions for installing and operating the pumps. Sections are devoted to pump specifications and actual results as well as the measurement of water and other useful information. The book may be had for the asking by those interested in irrigating systems.

"IMPROVED METHODS of Connecting Small Turbines in Steam Power Plants and Exhaust Heating and Drying Systems" is the subject of a booklet distributed by the De Laval Steam Turbine Co., of Trenton, N. J., in which are described several methods of connecting small turbines for driving auxiliaries in large steam power plants, also in connection with exhaust steam heating and drying systems in isolated plants. The booklet contains suggestions which will be of value to anyone concerned with design or operation of steam plants.

MANY TYPES of brass valves are illustrated in the latest circular from Jenkins Bros., 80 White St., New York.

FROM AMERICAN MFG. CO., Noble & West Streets, Brooklyn, New York, we have received a new folder relating to "American" manila rope.

KANTKINK Flexible Metallic Hose is the subject of a folder from the Goodyear Tire & Rubber Co., Akron, Ohio.

A CIRCULAR illustrating Hyatt-Curtis roller bearing trolley and Hyatt standard bushing was recently received from Hyatt Roller Bearing Co., Newark, N. J.

NEW CIRCULARS FROM Lytton Manufacturing Corporation describe the following: Lytton perfect vacuum and lifting trap, Lytton return traps, steam traps for sugar factories, separating traps for saturated and superheated steam, pressure reducing valve for steam and air, boiler blow valve.

"MORE CHIPS," a pamphlet from the Electric Controller & Mfg. Co., Cleveland, Ohio, describes a system for controlling motor-driven machinery. It contains a reprint of an article entitled "Automatic Control of Machine Tools," which appeared in the American Machinist.

HEINTZ STEAM TRAP is the subject of a booklet just received. This trap consists of 4 essential parts and has no air valves, as the discharge is controlled automatically by the variations in temperature. It is manufactured by H. A. Rogers Company, 87 Walker St., New York.

"THE ECONOMICAL BURNING of Coal," a treatise on securing greatest economy, smoke prevention and ease with hand firing, forms the introduction to a pamphlet recently received. This is followed by description and illustrations of Ajax shaking and dumping grates and other varieties manufactured by Valley Iron Works, Williamsport, Pa.

"THE WHOLE 'KEWANEE' FAMILY" is the title of a 48-page illustrated catalog recently received. Characteristics of "Kewanee" unions are brass to iron thread connection, no inserted parts and compressed air test under water of each union. They are manufactured by National Tube Co., Pittsburgh, Pa.

"BUCKEYE-MOBILE, the American Locomobile," Bulletin No. 10B, describes for isolated steam plant users a steam power plant composed of internally fired boiler, tandem compound engine, superheater, reheater, feed-water heater and pump, with or without condenser; for belted service or with flexible coupling for direct connection to generator. Buckeye Engine Co., Salem, Ohio, is the manufacturer.

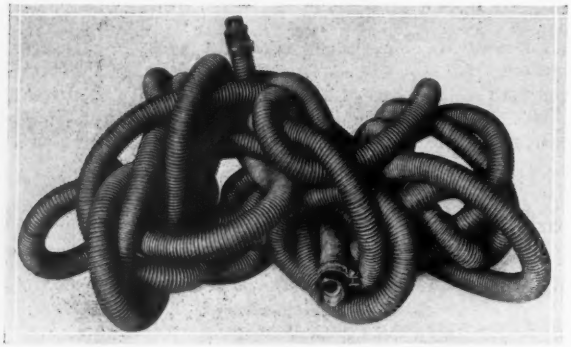
CATALOG K, from the Brown Hoisting Machinery Co., Cleveland, O., gives a general description of Brownhoist locomotive cranes of various capacities, and shows by illustrations how the cranes are used in connection with Brownhoist patented grab buckets. A list is also given of other illustrated catalogs on cranes and other Brownhoist equipment. Any of these catalogs will be sent on application.

TRADE NOTES

WESTINGHOUSE ELECTRIC & MFG. CO. reports the receipt of the following orders:

For Centralia Gas & Electric Co., Centralia, Ill., one 200-kw., 600-volt, 3-phase, 60-cycle, 1200-r.p.m. rotary converter with 3 75-kw., 2200-volt, high tension transformers; for City of Cleveland, O., 2 300-kw., 250-volt, 3-phase, 60-cycle, 900-r.p.m. rotary converters with 2 330-kv.a., 3-phase, 2300-volt, high tension, OISC transformers and a switchboard; for Maryland Electric Railway Co., Annapolis, Md., 4 300-kw., 1200-volt, d.c., 3-phase, 25-cycle, 750-r.p.m., self starting, rotary converters and 4 300-kw., 13,200-volt, high tension, 3-phase, OISC transformers and 2 switchboards; for Hartford Electric Light Co., Hartford, Conn., one 200-kw., 250-125-volt d.c., 3-wire, 2300-volt a.c., 2-phase, 60-cycle, 900-r.p.m., synchronous motor generator; for Sears Roebuck & Co., Chicago, Ill., one 1500-kw., 228-volt, 360-r.p.m., compound wound commutating pole turbine reduction gear driven generator.

HEREWITH is an illustration showing the possibilities of the new Kantkink Flexible Metallic Hose which is made by the Goodyear Tire & Rubber Co., of Akron,



O. Of course, no such tying up into knots would be required in practice, but this shows the flexibility, and that there are no edges to catch and no chance for short twists.

THE VILTER MFG. CO., with offices at 972 Clinton St., Milwaukee, Wis., reports the following list of recent sales: Independent Ice & Cold Storage Co., Pasadena, Cal., 25-ton can ice tank and equipment; Wills-Jones-McEwen Co., dairy, Philadelphia, Pa., 75-ton refrigerating machine, ammonia compressor, direct connected to one 18 by 36-in. Corliss engine; Stegmaier Brewing Co., Wilkes-Barre, Pa., 12 by 24-in. Corliss engine; W. T. Wescott, chocolate mfr., Camden, N. J., 23-ton refrigerating machine belt driven; Milwaukee Western Cold Storage Co., Milwaukee, Wis., 120-ton refrigerating plant, belt driven; Schuster Brewing Co., Rochester, Minn., 42-ton refrigerating machine, direct connected to 14 by 30-in. Corliss engine; Twin Cities Cold Storage Co., Minneapolis, Minn., 14 by 24 by 30-in. cross-compound Corliss engine; U. S. Government War Dept., Memphis, Tenn., 3 raw-water can ice-making plants with 2 5 by 6-in. and one 6 by 8-in. double-acting ammonia compressors direct connected to vertical steam engines.

F. A. HAVENS & Co., 845 North Nineteenth St., Philadelphia, Pa., is estimating on plans and specifications for a power station to be erected at Burlington, N. J., for the Public Service Electric Co., of Burlington.

PRACTICAL ENGINEER

Trade-mark reg. U. S. Pat. Office.

SEMI-MONTHLY

PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH

Subscription price in advance in the United States, Mexico or united possessions, $1.00 a year.

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Advertisements in this section are inserted under regular headings.

No display type allowed, but the first three words may be set in capital letters.

About nine words make a line. Minimum space sold, two lines.

Under classification "Position Wanted," advertisements not exceeding four lines will be inserted once for subscribers free of charge.

All copy should be received at Chicago office 18 days before date of publication.

Circulation of this issue, 23,500

Technical Publishing Co.

537 S. Dearborn Street

Chicago

Positions Wanted

POSITION WANTED—As mechanical draftsman and designer. College graduate, mechanical engineer. Completed two correspondence courses in drawing. Over year's practical drafting. A-1 references. Edward Skillman, Tribune, Kansas. 8-15-3

POSITION WANTED—Watch Engineer in medium sized hydro-electric and reciprocating engine plant, desires position as chief in a similar plant. Good references. Liberal education and experience. Address Emerson B. Tifft, Box 606, Broad Brook, Conn. 8-15-3

POSITION WANTED—Swedish, age 30, journeyman blacksmith with 6 years' experience as master mechanic in large sprinkler and steam supply house and 4 years' experience in repairing steam and gasoline engines. Wish position as master mechanic or general foreman with a sprinkler and steam supply or automobile firm. Address H. E. Wackeline, Natic Ave., Greenwood, R. I. 8-15-3

POSITION WANTED—As Chief Engineer on or about September 15, 1913. Age 40 yrs., with 25 yrs.' Practical and Theoretical training, 5 yrs. with present employer. First class New York License. Own Indicator and a good set of tools. Address Box 311, Practical Engineer. 9-15-1

POSITION WANTED—As Electrical Engineer; at present in charge of large electrical plant in New York. 12 years' technical and practical experience. Strictly sober and industrious. Address William MacInally, Pleasantville, N. Y. 8-15-3

POSITION WANTED—As Engineer in small plant, or assistant in a large plant, by man of 28 yrs. No bad habits, 3 yrs. machinist experience; understands A. & D. current; holds local engineers' license. C. H. Freeman, 57 North St., Elgin, Ill. 9-1-2

WANTED—Position as assistant engineer in large electric power plant or chief in small plant; 14 years practical experience operating electrical and ice making machinery. Age 36, sober and steady. Correspondence invited. Address C. E. C., Box 316, Practical Engineer.

POSITION WANTED—By first-class Steam Engineer. A. and D. current. Can give results and best of reference. Sober and steady, 14 yrs.' experience. Address Box 309, Practical Engineer, Chicago, Ill.

Wanted

WANTED—Secretary of local Engineers' Association to write us at once in regard to a very interesting proposition. Address Practical Engineer, Circulation Department.

MANUFACTURER'S REPRESENTATIVE, favorably known and of wide experience in modern engineering, wishes to handle power-plant equipment, engines, boilers, stokers, etc., in Pittsburgh district. Daniel Ashworth, M. E., 1225 Fulton Bldg., Pittsburgh, Penn. 7-15-4

WANTED EVERY ENGINEER to have our pamphlet for setting valves on Corliss Engines, simple and compound, with one or two eccentrics. Sent free. Lindstrom's Machine Works, 200 South Third St., Allentown, Pa. tf.

WANTED—ALL STEAM USERS to have clean boilers without using compounds or chemicals in any form. Write "Otis," No. 317 Norfolk Ave., Buffalo, N. Y. tf.

IF YOU ARE a night engineer, spend a few hours each day taking subscriptions for Practical Engineer. You will be paid well. Write Subscription Dept. They will start you in at once.

WANTED—Every local Engineers' Association to have an assortment of valuable power plant books—Secretary write at once, for full particulars. Address Dept. C., Practical Engineer, Chicago.

Help Wanted

WANTED—An additional subscription solicitor wanted to cover towns in the state of Indiana. Excellent chance to earn extra money. Write to Subscription Department. tf.

For Sale

FOR SALE—One 125 hp., three cylinder, producer gas engine, without producer. Can be changed to use coal gas or natural gas. One six-inch Hill line shaft 40 feet long, with pulleys, clutches, etc., same as new. Board of Public Works, South Haven, Mich. 9-1-2

FOR SALE—125-h.p. boiler, 100-h.p. engine, in good condition. J. P. Vogan, Franklin, Pa. 9-15-1

Patents and Patent Attorneys

PATENTS THAT PROTECT AND PAY. Advice and books free. Highest references. Best results. Promptness assured. Send sketch or model for free search. Watson E. Coleman, Patent Lawyer, 624 F Street, Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established, 1883. I make a free examination and report if a patent can be had and the exact cost. Send for full information. tf.

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. 186 McGill Building, Washington, D. C. tf.

THE PATENTOME is interesting and instructive. A liberal education in patents and how to get them. Free on request. Establish, 1865. Anderson and Son, Patent Solicitors, 710 G St., Washington, D. C. 9-1-2

PATENTS SECURED. Legal protection our specialty. Booklet free. Harry Patton Co., Suite 330, McGill Building, Washington, D. C. tf.

PATENTS SECURED. Take advantage of my personal experience, send sketch or model. Get my free book containing 200 mechanical movements. W. N. Roach, Jr., 951 McGill Bldg., Washington, D. C. 9-15-1

PATENTABLE IDEAS WANTED—Send for 3 free books. R. B. Owens, 28 Owens Bldg., Washington, D. C. tf.

Educational and Instruction

ENGINEERS' POCKET MANUAL. 175 pages, edited by University of Tennessee, will be mailed every subscriber sending in one new subscription to Practical Engineer. Gild edges, bound in leather.

Miscellaneous

IF YOU ARE an operating engineer, we know the Fetta Hot Process Water Purifier will interest you. We would be glad to have your request for further information. Address the Fetta Water Softener Co., Richmond, Ind. tf.

ENGINEERS—DO YOU WANT to utilize your exhaust steam for heating or dying purposes, without back pressure on your engine? If so, address Monash Engineering Co., 1413 W. Jackson Blvd., Chicago, Ill.

MAKE MONEY on the side. Here's your chance to work out some money for yourself. Get subscriptions for Practical Engineer. It pays well. Just drop a line to the Subscription Dept. They will tell you. tf.

Sparks On The Advertising Pages

Some months ago, the late J. Pierpont Morgan startled the business world in a statement made before a congressional committee, that his bank had loaned, without security, a large sum of money to a man whom he (Mr. Morgan) knew had no property or money.

A short time before, the press of the country in chronicling some peculiarities of an American playwright and theatrical man, said, "Notwithstanding the fact that the receipts of the Cohan and Harris productions run into the millions, and that this firm owns magnificent theatres in Chicago, New York, and other cities, there has not been so much as a scratch of the pen binding the partners. Geo. M. Cohan leaves all financial affairs to his partner, Mr. Harris."

John D. Rockefeller, in instancing how he accidentally met John D. Archbold at a hotel in an obscure country city, related that he immediately felt a confidence in Archbold. The result was, Archbold joined the Standard Oil forces, and succeeded Rockefeller as the main force behind this organization.

Confidence plays a mighty big part in the transactions of this world. It is not only the basis of credit, but it is generally a big factor in the success of an individual or firm.

It enters into your daily work. If the time should come when your firm should lose confidence in your engineering ability, you would be out of a job. Therefore, it is up to you to forestall any possible depreciation of your services by upbuilding the foundations on which this confidence rests.

Most of the stones in this foundation are labeled, "Knowing How." Knowing how to operate your plant economically; knowing how to meet emergencies; knowing how to care for the growth of power plant demands with least expense; and knowing how to buy in the supply and equipment market.

It is in these connections that Practical Engineer is of extreme value to you. Its editorial pages are filled with articles which concern actual power plant problems, and men standing high in the engineering profession give you the benefit of their experience and knowledge.

The policy of Practical Engineer is,—first, to publish a paper for power plant engineers. All other considerations,—owners, superintendents, advertisers, etc.,—are secondary. So, naturally, we are constantly striving for the confidence of those who read our paper.

This is especially true of our advertising policy. We have confined our advertising pages exclusively to those products which are useful to you in your every-day work. And, where there has been doubt you have been given the benefit of it.

In short, the policy of our entire staff, is to make Practical Engineer the paper that power plant engineers will turn to for aid and dependability.

Instance after instance has come to our attention which show that we have chosen the right path. One of the latest noticeable cases is that of a subscriber in East Jordan, Michigan, who inquires about the standing of a former advertiser, closing his letter as follows:

> "I notice that their advertisement had but a short run in Practical Engineer. This has caused me to doubt their reliability. I would appreciate your opinion in the matter."

As a subscriber to Practical Engineer, YOU are one of the parties to every contract signed with our advertisers. If they cannot benefit YOU we do not want their advertising.